ECOLOGY, HISTORY, MANAGEMENT AND CONSERVATION OF THE MULTIPURPOSE FOREST OF WYRE

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This work or any part thereof has not previously been presented in any form to the University or to any other body whether for the purposes of assessment, publication or for any other purpose (unless previously indicated). Save for any express acknowledgements, references and / or bibliographies cited in the work, I confirm that the intellectual content of the work is the result of my own efforts and of no other person.

Signature P. R Hobson

Date 20.9.97

A B S T R A C T

There were three principal aims to this study: to provide an accurate historical account of the management of Wyre Forest over the last millennium and to interpret these events by analysing existing forest vegetation; to describe in detail the phytosociological nature of the forest and determine a range of environmental factors which influenced these vegetation patterns; and to suggest an effective conservation strategy on the basis of the findings of this study and an understanding of conservation science.

Scant historical records coupled with a more detailed contemporary oral account identified three periods in the history of Wyre: the Medieval times when the forest was managed as a Chase and deer parks under the ownership of the Mortimer family; the 16th century to the turn of the 20th century- a very active period of rural industrial development, interrupted by deforestation; and the last 90 years when traditional woodland practices were abandoned and modern silvicultural management was introduced with new plantings.

Traditional coppicing in Wyre involved both frequent cutting of small wood and the careful singling of chosen stems over a prolonged rotation of 70 to 125 years to provide for the garden centres, tanneries, mines and steel industries. Charcoal was a major product of the forest. By analysing stem density and diameter data, and by measuring the proportion of birch in the wood four main structural stands were statistically recognized. These stands related to past and present silvicultural practices. Significant differences in oak stem densities between woodland sites reflected more recent attention paid by foresters to local soil variations.

A vegetation analysis identified six stand-types although considerable floristic grading across community boundaries suggested a broad complex western oak-wood association. Ordination analysis recognized three factors partially responsible for the plant assemblages: complex soil patterns; a long history of management; and the impact of intensive browsing by deer. In particular, recent coppicing significantly altered plant assemblages by promoting less typical forest stand-types.

Furthermore, a comparative analysis of coupe and high forest vegetation indicated a significant difference in structural heterogeneity brought about by deer browsing pressure. Greater heights of birch and oak seedlings, and bramble were apparent in the enclosed coupes.

Conservation management should aim to achieve a balance between coppicing and the problems of edge-effect created by this activity by promoting small randomly spaced glades throughout the forest which are cut on a more natural rotation cycle. Deer numbers should be governed according to the extent of damage they exert on the forest vegetation. Both plantation and natural forest could be managed on a selective system. Recreational activities should be controlled through capping and zoning.

ACKNOWLEDGMENTS

This thesis has been a lengthy undertaking, on many occasions a facinating experience, spanning a period of almost seven years. Despite some major disruptions and distractions including changing jobs three times, moving to a new county and parenting a young and expanding family progress on the thesis finally reached completion. There is little doubt that this would not have been achieved without the continued support of my project supervisor, Professor Packham, who demonstrated with ease that geographical displacement of considerable distance between tutor and student was of little consequence to effective communication and supervision. Throughout the progress of my research Professor Packham offered me the benefit of his professional expertise in critically analysing the various stages of my work. I am also grateful to my external supervisor, Professor Willis, who has contributed clarity of thought and depth of understanding to my research through his careful scrutiny of the results and discussion. Professor Willis was also generous in his willingness to give up his time to travel some distance in order that we may meet to discuss the progress of my thesis.

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C O N T E N T S

CHAPTER 1

1 A PERSPECTIVE ON FORESTS

1.1 DEFINING THE TERM "MULTIPURPOSE FOREST"

This study of the Wyre Forest is intimately related to the concept of the multipurpose forest, which is as old as early man. Primitive hunter-gatherer tribes scattered across the tropics and sub-tropics tapped forests for medicines, food and wood for fuel and implements. Later, Neolithic peoples browsed their livestock in forests across Eurasia, the birth of civilization and the beginnings of agriculture marking a fundamental change in the relationship between man and forest. In Eurasia, fields of wheat and rough pasture gradually replaced woodland. Whole nations were later to fight for new territories because their own forests and soil had been despoiled (Arvil 1967). In Europe, until 3000 years ago, small tribal populations made extensive use of the forests as mines of timber, skins, and food supplies (mines are areas of exploitation where sustainability is irrelevant, Oldeman et al. 1994). After this period the treatment of forests as mines entered a new phase as people's needs could no longer be met from the original forest. The intensification of production involved the clearance of forests to make way for nomadic agriculture (Oldeman et al. 1994). The history of European forests cannot be separated from the development of populations and the needs of human civilization (Touzet 1994). Forests in Europe have been shaped according to the density of human occupation of the land. Clearing and replanting of forest areas as well as the modeling of woods according to the needs of the individual or the community were a direct result of human activity (Touzet 1994).

It has taken the wanton destruction of forests across Europe, America and Asia, together with the more recent devastation of the tropical forests, to raise awareness of this global multipurpose resource. Ironically, the few remaining forest-dwelling tribes left in Africa, Southeast Asia and South America have known all along.

Despite the ancient association between man and forest, the term "multipurpose forest" is a modern one, although European forest laws governing the operation of such forests go back many hundreds of years. In 1769 parliament passed an Act "for the better preservation of hollies, thorns, and quicksets in forests, chaces and private grounds and of trees and underwoods in forests and chaces.".(this Act deals with several other matters including custom duties). In 1773 an Act was passed for the better preservation of timber trees shrubs and plants, including poplar, alder, maple, larch and hornbeam (James 1990). The act symbolized a commitment to the preservation of Europe's supplies of timber. Coinciding with the industrial revolution, Europe also saw a blossoming of private reserves and parks in tune with an idealized conception of nature. The Neuenburger and Hasbrucher Urwalder (primitive forests Reserves) in Germany are nearly 120 years old and the "virgin forest" of Suserup in Denmark nearly 200, while the Czech and Slovak nature reserves were first introduced in 1838 (Oldeman et al. 1994). In Sweden the Forest Service controls hunting in the State forests and is also responsible for managing woodland recreation, and maintaining forest amenity areas (Duffey 1970). In Sweden over 80% of all land below the treeline is forested, so it is of little surprise that this country has 766 forest reserves which for many years have been maintained for recreation and conservation. Sweden has also recognized the need to manage 1,850,000 acres more of uneconomic forest as a nature reserve (Duffey 1970).

In the 1920s, Swiss foresters were advocating an ecological approach to their work. Although other foresters dismissed them as dreamers, they found support in central Europe. Ecological forestry in Europe, as represented by the Pro Silva Association, is now thriving more than ever (Oldeman et al. 1994).

However, it is to America that one has to look for the origin of the term "multipurpose forests", although, multipurpose practices can be traced back for many hundreds of years in Britain (Packham et al. 1992) In 1960 the U.S. Congress introduced the Multiple-Use-Sustained Yield Act which redefined the use of the National forests (Packham et al.1992). In addition to timber production, other aspects of forestry covered by the Act were outdoor recreation, soil, watershed, wildlife and fishing. It was the responsibility of the U.S. Forest Service to ensure that this policy was properly executed. These objectives are, in general, now practiced in multipurpose forests in much of the developed World.

In the U.K, the main concern of the government before WW2 was to establish and maintain a strategic timber reserve, although a number of Forest Parks were established in Scotland, Wales and England before 1940 (Forest Enterprise 1992).

However, in 1957 the government accepted the recommendation of the Zuckerman Committee on Forestry, Agriculture and Marginal Land that the Commission's future objectives should be of a commercial and social nature (Forestry Commission 1990b). In the 1960s, the Forestry Commission adopted the ideas of the landscape consultant Dame Sylvia Crowe (1978), and used her guidance for woodland design. In 1989, the Forestry Commission published Forest Landscape Design Guidelines. In the same vein of multipurpose forests, woodland management is identified as a desirable land use for public recreational activities (Irving 1985) and to this end there has been considerable development in the provision of resources. The Countryside Acts of 1967 and 1968 recognised the importance of national forests for public recreation, and granted the Commission powers to provide facilities such as camp sites, picnic places and visitor centres. Advice on recreational planning in private woodlands can be obtained from the Regional Tourist Boards, Sports Councils, the Ramblers Association, the Countryside Commission and the Forestry Commission. Notable guidelines are also provided in the publication, "The Forestry and Woodland Code", produced in 1985 by Timber Growers UK (Hart 1991).

Finally, wildlife conservation has more recently surfaced as a desirable form of integrated forest management and now enlightened foresters seek to achieve a balance between wood production and nature conservation; indeed they have a statutory duty to do so under the Wildlife and Countryside (Amendment) Act of 1985. In 1990 the Forestry Commission published 'Forest Nature Conservation Guidelines'. Apart from the Forestry Commission, the successors to the Nature Conservancy Council, and the National Trust, there are a number of other organisations which pay particular attention to woodland conservation including the Woodland Trust (national), Project Sylvanus (Devon, Cornwall and Somerset), National Small Woods Association (England), ESUS Woodland Management (East Sussex and Kent), Cumbria Broadleaves Group, Coed Cymru (Wales) and the Forestry Trust for Conservation and Education - England (Hart 1991).

A consultative government document published in June 1972 placed considerable emphasis on rural employment, but also included enhancement of the environment as a major justification for continued government support for both Forestry Commission and private planting. The three main objectives of maintaining a strategic timber resource, providing employment, and enhancing the environment were given added strength by a further comprehensive review of forestry policy undertaken in 1979-80. This policy statement identified the need for a continued expansion of forestry which would also enable the preservation of an acceptable balance between environmental and other interests (Forestry Commission 1990a). In 1993 a conference in Helsinki on European sustainable forestry outlined key policies for the development of an economically viable and environmentally sensitive forestry programme. A key objective stated at this conference was the need to safeguard biodiversity. For its part Britain strengthened its commitment to forestry by pledging a doubling in the extent of forest cover in the UK over the next 60 years (Kirby and Rush 1994).

The House of Commons Environment Committee produced a report in 1984 on the operation and effectiveness of the Wildlife and Countryside Act of 1981. In accordance with this report the Forestry Act of 1967 was amended by the Wildlife and Countryside (Amendment) Act of 1985 which placed a duty on the

Commission to endeavor to achieve a reasonable balance between forestry and the needs of the environment (Forestry Commission 1990a).

Finally, in 1985 the Woodland Grant Scheme was introduced. This incorporated a wide range of management objectives designed not only to produce timber, but to encourage the development of multipurpose woodland management (Forestry Commission 1990a). The thinking behind the development of a multipurpose use policy for state-owned forests has been the understanding that for centuries ancient medieval forests such as the New Forest, the Forest of Dean and Wyre have thrived under this form `of management. It comes as no surprise, therefore, to discover that these ancient sites were some of the first to be earmarked for an ambitious programme of recreational development, which is still on-going.

In recent years Government has vigorously promoted commercial forestry in the private sector while at the same time investing heavily in the recreational development of state-owned woodland. This policy has been extremely successful in opening up forests to the public and in some areas of the country recreation has outstripped other non-commercial objectives including conservation and scientific uses. Where this has happened in ancient woodland it has not infrequently created new anxieties amongst conservation organisations.

The understanding that knowledge of the history of a woodland is fundamental to maintaining the ecological integrity of a site in the face of modern-day practices has been effectively promoted, in recent years, by such authors as Peterken (1981, 1992), Rackham (1976, 1980, 1986), and Booker and Tittensor

(1992). Most ancient woodlands today are surveyed with this in mind prior to any form of major management.

1.2 AN INTRODUCTION TO ANCIENT WOODLAND AND MEDIEVAL FORESTS

After the last Ice Age Britain witnessed successive waves of climax-forest types. During the early Flandrian period (10,000-8500 years BP) the rapid warming of the climate had allowed birch to spread over almost all of Britain. Pine was widespread but still largely confined to the south. Towards the end of this period conditions improved and hazel became abundant throughout the country (Godwin 1975).

By 7800 BP Britain was cut off from Europe with the flooding of the North sea and the climate gradually became more oceanic. This period, the mid-Flandrian (8500-5000 BP), marked the succession from birch/pine forest to the domination of the landscape by broadleaved woodland (Petty and Avery, 1990).

The forests of the Atlantic period in Britain were the last which could be described as primary, their distributions determined by natural environmental controls (Godwin 1975). The distribution of species in these Atlantic forests was very similar to that of those fragments of semi-natural woodlands which still exist (Godwin, 1975; Birks et al. 1975). In general, *Tilia cordata* forests dominated in the south, *Quercus-Corylus* woodlands in Wales and north England, *Pinus/Betula* forests in northern Scotland, and *Corylus-Ulmus* woodlands in Ireland (Rackham 1986). These forests would have had a shade-tolerant community similar to still extant virgin forests (Peterken 1981). Present day "primary" forests like Bialowieza, Poland, show a very heterogeneous community with several stand types including lime/hornbeam (Tilio-Carpinetum) dominated stands, oak/hornbeam (Querco-Carpinetum) stands, and pine/oak (Pino-Quercetum) dominant woodland (Wiecko 1984). These woodlands commonly have a very diverse field layer which includes *Allium ursinum, Potentilla sterilis, Convallaria majalis, Anemone nemorosa, Aquilegia vulgaris, Dryopteris filix-mas*, and *Paris quadrifolia.* More light-tolerant species such as *Pteridium aquilinum* and *Salix* spp.would have occurred in areas of the forest where a temporary *clearing was created* by an old tree fall (Peterken 1981). However, it would be misleading to assume that the primary forests which covered Britain were closed canopy. This wooded landscape was home to large herbivores capable of browsing back any tree regeneration in some of these temporary clearings and by doing so thus maintaining these glades on a more permanent basis. This is a view held by Rose and James (1974) following their studies of epiphytic lichen communities in the New Forest.

From 4000 BP the climax forest, or wildwood, covering much of Britain started to decline under the impact of climatic change towards progressively wetter weather and the activities of Neo-lithic people. In England the loss of much of the elm has been attributed to its selective use as a feed for domestic stock in particular cattle (Godwin 1975), though Rackham (1986) postulates that the diminution in the pollen record may alternatively have resulted from an early epidemic of Dutch Elm Disease. However, the impact of man seems to have been uneven. In south-east England clearance was widespread as early as 3700 years ago (Godwin 1975), whereas woodland in much of the Highland Zone was only locally and temporarily cleared until 2500 years ago (Turner and Hodgson 1979).

Whilst it is accepted that coppicing was very much in evidence in the Neolithic (Rackham 1980; Peterken 1992), the extent of forest clearance at that time is uncertain. Godwin (1975), Peterken (1981) and Rackham (1986) consider extensive and widespread forest clearance but, set against this, is the earlier view of Hoskins (1955) of the activities of Neolithic man. Hoskins estimates the population of Neolithic man in this country at somewhere around 20 000. He maintains that communities led a nomadic existence combined with small-scale semi-permanent settlements. If these views are given any credence it is plausible that very substantial areas of wildwood existed during Neolithic times. Populations were probably concentrated along major rivers and on high ground (as also suggested by Rackham 1986). There are two possible arguments relevant to the impact of early man on the forested landscape. In the first scenario, Neolithic man formed small, temporary and localised settlements throughout the country, clearing patches of woodland from high altitude areas and river valleys. After a while settlements would move on leaving the open spaces to regenerate to forest. This social pattern would have resulted in the population being widely dispersed and thinly spread across the country. The "wildwood" would have suffered less from this social pattern than one in which the settlements were larger and more permanent. The clearance of woodland would have been more systematic and sustained by crude cultivation and pasturalism. This second view is the one most readily accepted by the above authors. However, it is the extent of clearance that is a point of contention. Peterken and Rackham argue that much of the destruction was seen before the Roman conquest of Britain (Rackham maintains that half of England had ceased to be wildwood by the early Iron Age -

500 BC), whereas Hoskins (1955) considers that the impact on the wild forest before this time was relatively limited. What is certain is that clearance of forests was both localised and had a regional pattern. Much forest on the plateaux and high ground was probably left intact whilst that of the river basins and fertile plains was cleared. Furthermore, many of the temporary clearings would have regenerated, giving rise to a patchwork of secondary woodland and scrub within a mainly forested landscape. Marginal land, similar to these few unimproved areas still existing in mid-Wales and the western counties, would have been a common feature of the Neolithic landscape (present day marginal land in mid-Wales is locally known as ffriddland; it is usually a mixture of rough grass and bracken with varying amounts of gorse, hawthorn and rowan. Where gullies cut across this land, remnant woodland often survives).

The clearing of forests coupled with agricultural development of land increased strikingly throughout the Bronze and Iron Age (Dimbleby 1984). By the time of the Roman invasion of Britain agriculture dominated the southern English landscape. Little in the way of historical record of land use has come down from Roman times, although it is generally accepted that steady clearance of the forest continued.

Early Anglo-Saxon incursions into the British countryside witnessed a change to a more productive system of farming than that employed on the previous Roman estates, many of which had fallen into disuse. Many of the Romano-British farmsteads which had reverted to secondary woodland or scrub were cleared once more (Hoskins 1955). The Saxons brought a sophisticated agricultural system which enabled them quickly to clear the forest and turn it to productive land. The Anglo-Saxon Charters which date from about AD 600-1080 contain about 840 perambulations covering mainly the southern half of England (Rackham 1986). They provide details on lanes, hedgerows, woods and even ditches. However, what is surprising is that little mention is made of the large forests such as Wyre. Some of the best evidence on the extent of forests comes from studying old place names (Rackham 1986). In Worcestershire, for example, clearance of land by the Saxons occurred predominantly in the valleys of the Avon and Severn. North and west of the Severn forests persisted (Green and Westwood 1991). This part of the county supported only a few farmsteads scattered throughout a wooded landscape. Place-names ending in 'ley', 'leigh', 'heath', and 'field', for example Arley, Highley, Maxfield and Bewdley, signified clearances in forests.

So what of the great forests that still existed during this period? Although the Danes and the Saxons had reserved areas of forest and heath for hunting, it was the Normans who capitalised on these reserves and who codified forest laws which were to remain in force for several hundred years (James 1981). By the time of the Domesday Survey of 1086, the landscape of lowland Britain had evolved into a pattern still recognizable today. It has been estimated that by 1700 forest comprised around 12% of the British landscape (Holmes 1975). At the turn of the 20th century this area had been reduced to less than 5% of the countryside. However, the destruction of forest was not evenly spread; parts of Wales and the western counties were still heavily wooded. Most of the 'Chases' and 'Forests', using the terms in the Medieval sense, were delineated during the 12th century, at the end of which Forest Law applied to one-third of England (Peterken 1981). By this time most of the country's woodlands were modified with just a few primeval sites remaining in the remote areas of England and Scotland.

Medieval forests were a mixture of wood pasture, heath, woodland and parkland. The woodland was managed as coppice-with-standards. The underwood was usually cut on a 5-25 year rotation while the standards were managed on a multiple of the underwood rotation, in most cases less than 100 years (Peterken 1981). A certain number of standards were cut at the same time as the underwood and a similar number of saplings allowed to grow on to produce the next timber crop.

Coppice rotations varied considerably from woodland to woodland. In East Anglia some of the underwood was cut on a 3-year rotation whereas some woodlands were managed on a 40-50-year rotation. Thinnings were taken from these stands at 10-year intervals. Cleaning, the removal of unwanted species, was commonly practised in some woodlands. In woodlands managed as coppice-with-standards timber trees were overwhelmingly oak. These trees were rarely allowed to grow on beyond three times the coppice rotation (Peterken 1981). In many of the ancient woods grassy rides separated the underwood into several blocks and ditches were often constructed to help drain these areas (Peterken 1992). The coppiced underwood was usually bound by a hedge planted along the ridge of a wood bank. These hedges linked up with field boundary hedges across the landscape (Peterken 1992). Most of the forests and woodlands were used (Forest Law permitting) by local communities to graze or browse their livestock. Coppice coupes were more often than not delineated by an earth boundary usually surmounted by a hedge or wooden paling. Immediately after a cut the coupe was closed off and the entry of livestock and deer prevented, usually for

7-8 years. The plant communities which survive in many of these ancient semi-natural woodlands are reminiscent of primeval forests despite the centuries of woodland management and disturbance. Whilst coppicing over some considerable time may have altered the proportion of certain plant species it has had little apparent effect on the survival of key woodland plants (Barkham 1992). This may be true for woodlands traditionally worked for small wood production but may not be wholly representative of all woodlands, particularly those which have had a long history of grazing management. The presence of large herds of deer in certain forests has provided evidence on the impact of grazing on the ecology (Hobson 1992). In Wyre Forest Fallow deer frequently strip and crop back bramble only to promote more vigorous growth of bracken and creeping soft-grass (Hobson 1992).

1.3 WYRE FOREST: A CASE STUDY

At the time of the Domesday survey the countryside surrounding Wyre Forest was a mosaic of woodland, heath and meadows. In Worcestershire the Malvern Chase and Feckenham Forest extended south and east of Wyre. To the north and west of Wyre were the medieval Royal Forests of South-East Shropshire which included the small forest of Morfe (8 x 6 miles in extent), the rather larger forest of Shirlott, an area of 12 x 5 miles, and finally Clee Forest to the west. These Royal Forests were later known as the Royal Forest of Shropshire (FIGURE 1.3.1), and together with Wyre were originally part of the ancient Coed Mawr, or Great Wood (Wiggins 1986). As one of the oldest and largest semi-natural forests in Britain Wyre has progressed from being an important medieval Chase, passed through a period of intensive coppice management, to become a modern commercial

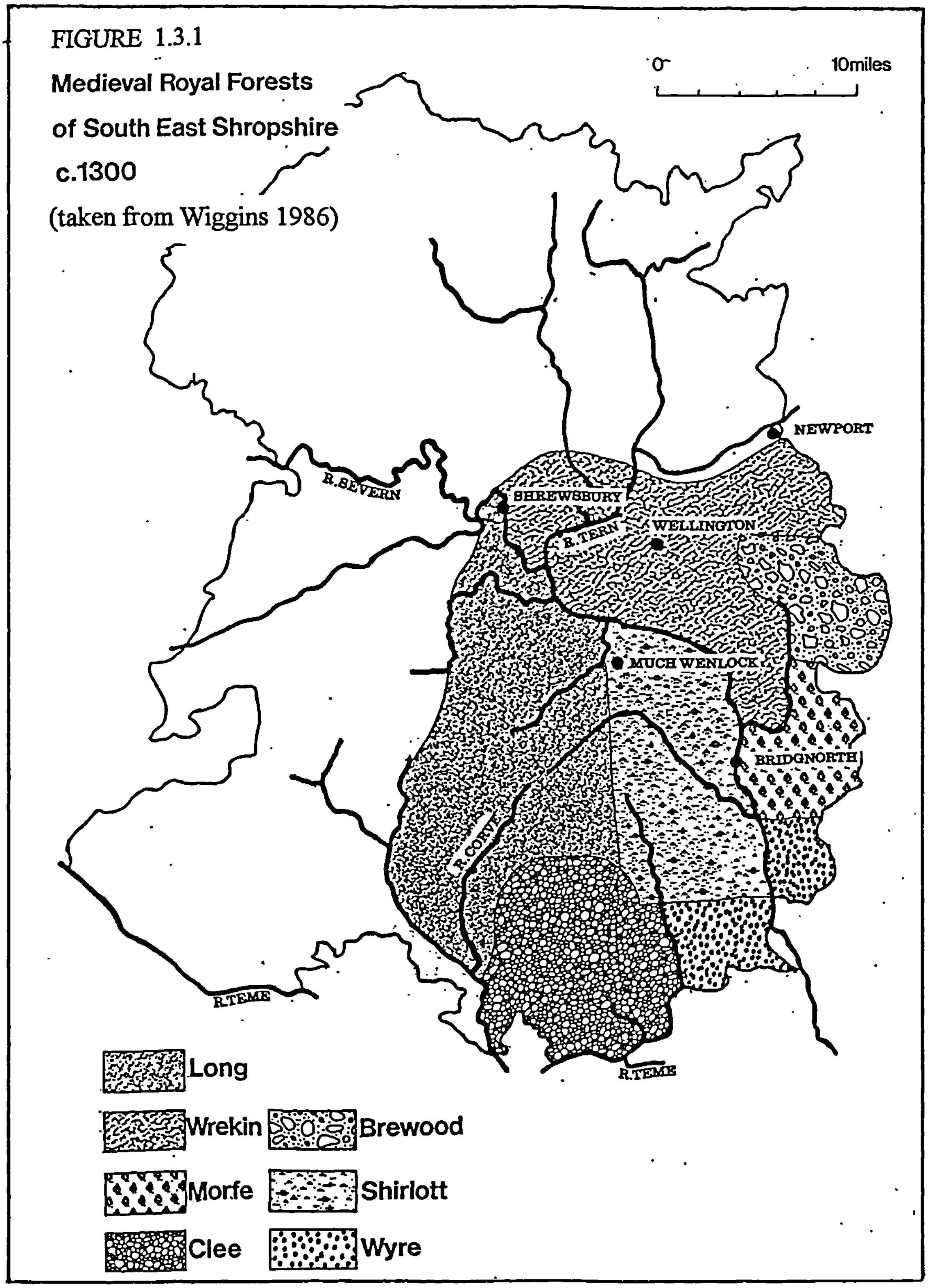

FIGURE 1.3.1
Medieval Royal Forests
of South East Shropshire
c.1300
(taken from Wiggins 1986)

woodland, and has finally emerged as a modern multipurpose forest. Past studies and records on the Wyre by Lea (1922), Salisbury (1925), Hickin (1971), Fincher (1976), Packham and Willis (1976), Guild of St George (c.1930), and George (1987) have helped in the understanding of the history and ecology of this ancient forest although much of the historical information is very sketchy and incomplete (Hobson 1995a). Past ecological research has also restricted itself to either giving a very broad overview of the forest or to very specific studies on aspects of plant ecology. Very little research has been done on the history and ecology of Wyre in the context of a more enlightened perception of traditional woodlands as portrayed by such authors as Peterken (1981, 1992,1996), Rackham (1976, 1980), Rodwell (1991) and Buckley (1992). This has not been helped by the paucity of information on similar forests from which comparisons could be drawn since much of the current research has been biased towards woodlands in the Eastern region of the country, although Linnard (1982) has provided a fine account of the history and utilization of the Welsh woods and forests. A further distinction in the management of woodlands can be drawn between predominantly rural areas and areas of the country which have witnessed large-scale industrial development (Wyre Forest fits into this last category).

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In recent years traditional views on land use have been replaced by a more progressive attitude which views the countryside as both a productive resource to be managed with a new environmental awareness and, increasingly, as a "public place" where the common citizen may develop a sense of the value of the countryside, whether it is visited for recreational, aesthetic reasons, or just for peace-of-mind.

This multifaceted approach to the countryside has rapidly developed, taking on ever more 'faces' to meet the new demands of an evolving society. Consequently, countryside management has become infinitely more complex. This diversity of interests sometimes causes fragmentation of the landscape, leading to a loss of continuity and ecological viability. This poses a problem to conservationists when it involves ancient semi-natural landscape. It is the multipurpose approach to landscape management which has prompted the move by conservationists to promote a much better understanding of the ecology and historical management of the country's wildlife resources. Indeed this conservation has, in recent years, taken its place amongst other earth-science subjects in many academic institutions.

Wyre Forest, prized for its considerable wildlife interest, is one such natural resource which has been launched as a flag ship to multipurpose forestry and yet there is still much to learn about the history and ecology of this ancient forest. With three elements of forest management well under way, commercial forestry, recreation and conservation, there is an urgent need further to establish baseline data which will provide the necessary information to evaluate the current ecological status of Wyre, as well as to serve as a starting point from which changes in forest ecology can be carefully monitored. It is the purpose of this research to assist in establishing a cohesive account and thorough understanding of the history and ecology of the forest. The findings from this study may also allow managers to take stock of developments and, where appropriate, modify management practices through a better understanding of the forest environment.

This study has five main objectives:

1. To provide a better understanding of the history of Wyre Forest from Medieval times to the present day.

2. To develop further field techniques of woodland archaeological study, thus enhancing the data-base where historical records are poor or absent.

3. To provide a detailed account of the vegetation patterns of the forest, and attempt to classify and describe the various plant communities.

4. To attain a better understanding of the relationships between past and present management and the plant life of Wyre.

5. To produce a conservation strategy which draws on information gathered during this study on the history, management and ecology of Wyre Forest.

The method of investigation involves conventional study techniques complemented by other approaches. In historical studies on forests and woodlands (Hoskins 1955; Peterken 1981, 1992; Rackham 1976, 1980, 1986; Booker and Tittensor 1992) the tendency is towards a general description of woodland management often based on a few detailed case studies. This fails to take into account local patterns and culture. For a detailed interpretation of local woodland practices a valuable supplement to research may be anecdotal sources which may be in the form of notes, letters, records or narration. Often, it is through oral records that a fuller picture of forestry and woodland management may be built up.

The approach adopted here to studying the vegetation of Wyre is a combination of standard well-tried surveying methods, but in addition the acquisition of evidence from other sources including mapping techniques.

1.4 PRESENTATION OF THE RESEARCH

The thesis falls into eight chapters; the second describes the site, materials and methods. The physical environment, very complex in Wyre, needs comprehensive treatment in this thesis if vegetation patterns are to be understood. Accordingly site description, geology, soils and local climate are covered in detail in CHAPTER 3, which includes an extensive analysis of the soil pH carried out in the present study. The account of the history and management of Wyre Forest in CHAPTER 4 is based on the literature, oral evidence and field-based work carried out as part of this research.

CHAPTER 5 is the first stage of the phytosociological study. It outlines the major plant communities of the forest and describes ancillary habitats. It also gives an account of the status of key plant species otherwise not covered in the analysis of the vegetation. CHAPTER 6 presents the findings of the main analyses of the vegetation and is divided into two sections of which the first examines the plant communities of the plateaux and the valley areas, and the vegetation of different silvicultural stand-types through Indicator Species Analysis. The second section is a full description of the ancient forest communities based on TWINSPAN analysis and matching observed data against National Vegetation Classification woodland communities. CHAPTER 7 draws conclusions from these findings, and finally, CHAPTER 8 attempts to present a realistic long-term conservation and management strategy for Wyre Forest.

CHAPTER 2

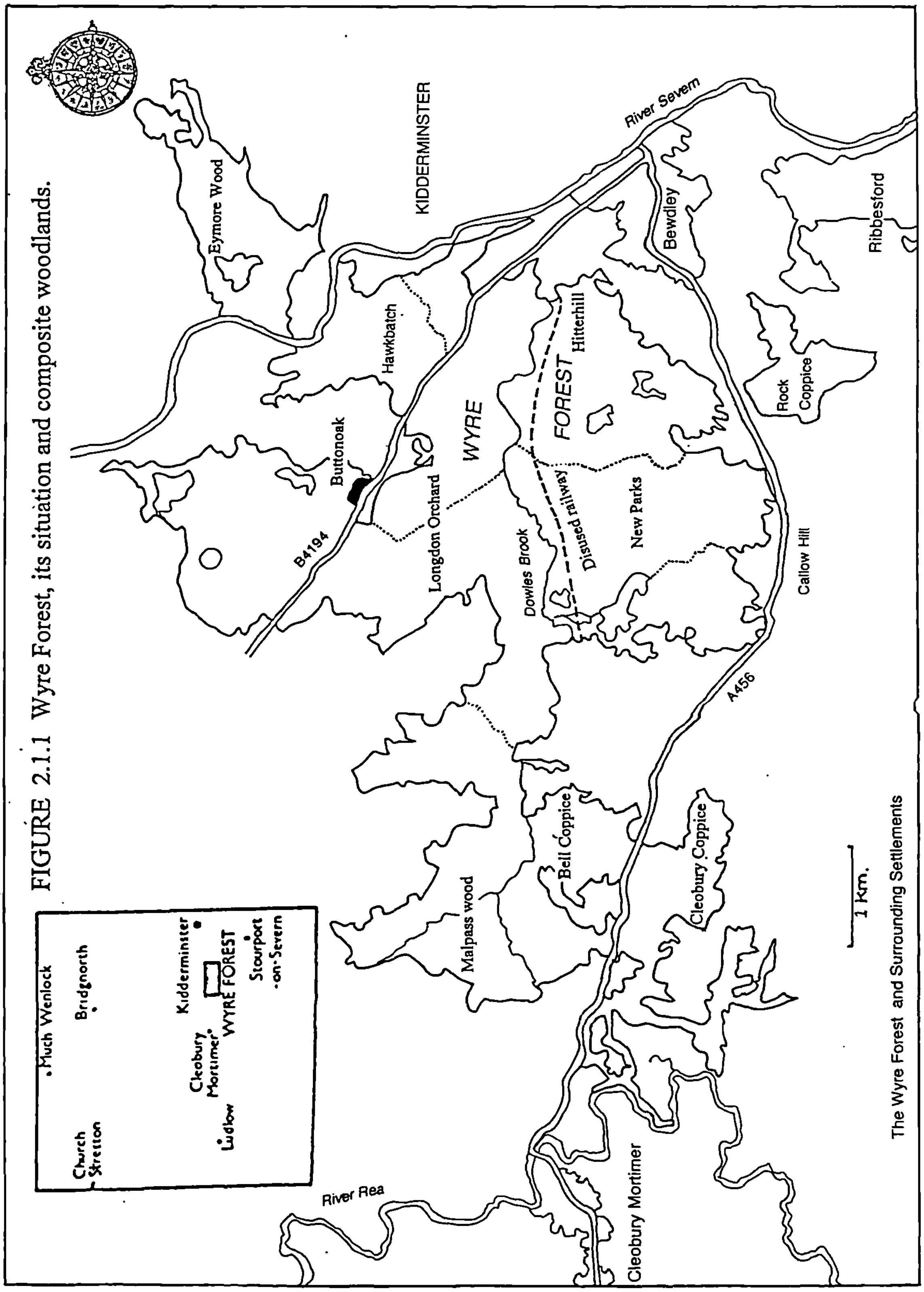
SITES, MATERIALS AND METHODS

2.1 THE STUDY SITE: WYRE FOREST

Wyre forest covers an area of 2429 hectares of the Shropshire and Worcestershire landscape. Its boundaries extend from the River Severn in the east, along the length of the Dowles Brook towards Cleobury Mortimer, five miles to the west (FIGURE 2.1.1). The southern edge of the forest is partly marked by Clows Top on the A456 road between Bewdley and Tenbury. The northern edge of Wyre is delineated by Buttonbridge Lane. The nearest town is Bewdley which lies on the banks of the River Severn. Within the main block, several large woodlands are clearly defined, including Cleobury Coppice, Bell Coppice, Rock Coppice and Hawkbatch. The forest represents one of the largest surviving areas of ancient forest in Britain, comparable in importance to the New Forest, the Wye Valley and Blean Woods (Nature Conservancy Council 1989).

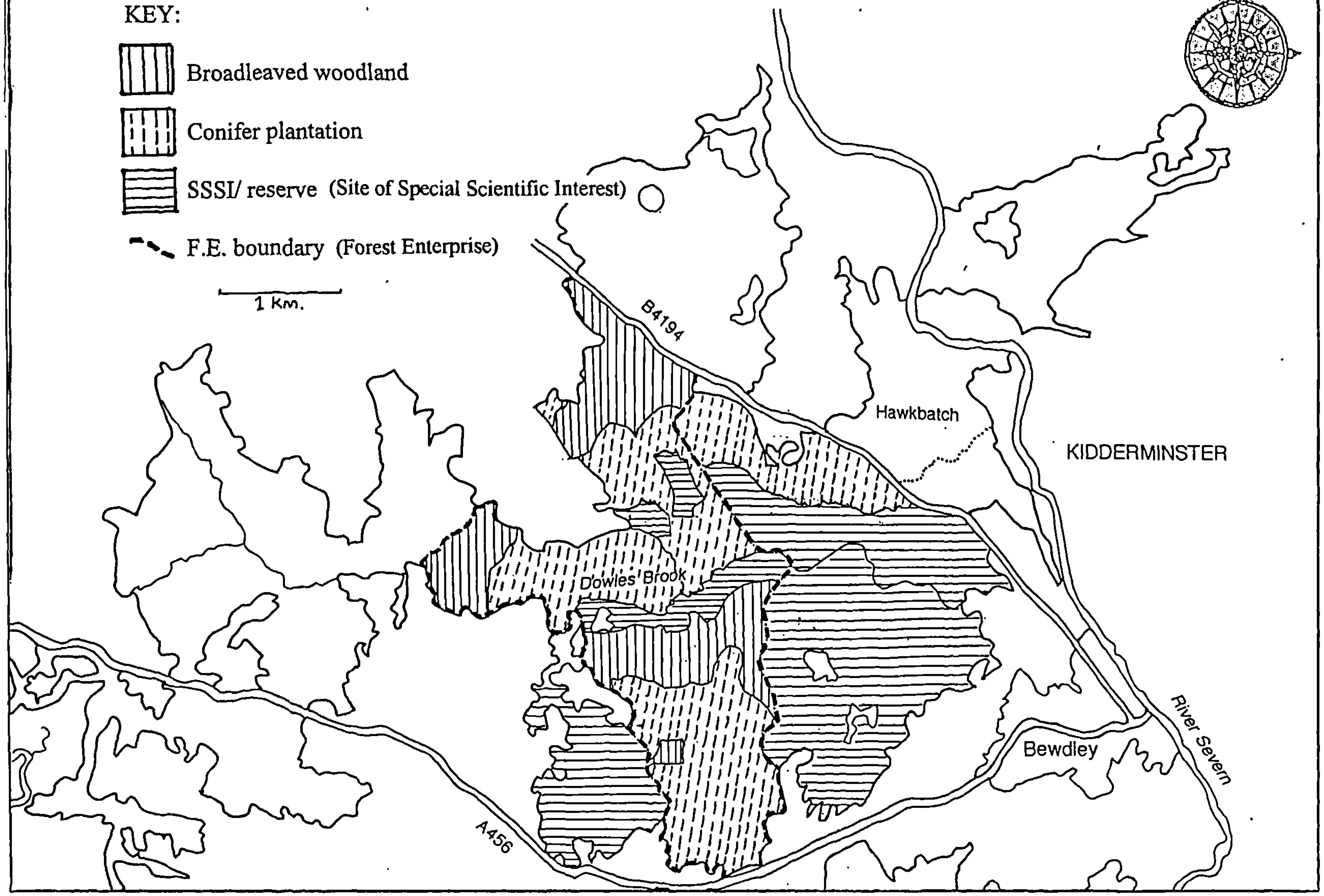
Most of the areas studied during the period of research were National Nature Reserve, SSSI, or owned by Forest Enterprise (FIGURE 2.1.2), which greatly facilitated access.

FIGURE 2.1.1 Wyre Forest, its situation and composite woodlands.



The Wyre Forest and Surrounding Settlements

FIGURE 2.1.2 Location of the study area, Wyre Forest.



The following summary gives the location of the forest:

Grid reference:	SO 67, OS Map Number: 138
Parishes:	Bewdley, Rock, Bayton, Kinlet, Cleobury Mortimer, Ribbesford, and Neen Savage.
Districts:	Wyre Forest, Leominster, Malvern Hills, Bridgnorth, South Shropshire.
Administrative Counties:	Hereford and Worcester, Shropshire.
Botanical/ Vice-counties:	Worcester (37), Shropshire (40) Staffordshire (39) (as delimited by H.C. Watson in 1852)

2.2 MATERIALS AND METHODS

These are presented in the same order as the chapters to which they apply.

2.2.1 Meteorological data

The installation by the Forestry Commission survey team of a Stephenson screen at Callow Hill between the years 1963 and 1986 provided valuable records for precipitation. In addition to these data local records of precipitation levels for Bewdley were used (Penistan 1963). More recently, a new Stephenson screen was installed at the Callow Hill Forest Office which allowed for readings of highest and lowest temperatures to be recorded each day for a year from 1989 to 1990. Information on prevailing winds including gales was obtained from Forestry Commission records.

2.2.2 Geology and soils of Wyre Forest

A detailed account, including the production of maps, was made of the geology and soils of the forest using information given by two authors: Penistan (1963); Oliver and Webster (1987); and Oliver (1995). This work was supported by a preliminary investigation of the soil to determine both the pH status and the organic layer of forest soils.

In the first instance a large number of pH readings (270 samples) were taken covering eight plantations within the state-owned part of the forest. The location of the samples corresponded to quadrat and transect points used for the ISA survey (section 2.2.6). In each case a core sample of soil was taken from just below the litter layer to a depth of 10cm to determine the pH. This analysis was carried out by mixing the sample with two parts water by volume and testing for pH electrometrically. Using the same sites selected for the ISA survey, eight quadrats measuring 200 m^2 were marked out, a single quadrat in each stand. Within each quadrat ten readings for litter layer; fermentation layer; and humus layer were made. The sampling carried out was a stratified random method and a total of 80 readings were made.

2.2.3 Mapping the hydrological features

To provide a detailed map of the hydrology of Wyre the forest was covered extensively on foot and all springlines, brooks and streams, as well as large wetland flushes, were mapped on to a 1:10 000 scale Ordnance Survey map.

2.2.4 Historical Studies of the Forest and its Management

Desktop Survey

Much of the information on the history and management of the forest was gathered from a wide range of literary sources, some of it archival (particularly the maps). Whilst the Domesday book of Shropshire and Worcestershire (Morris 1982, 1986) serves as a monumental record on land ownership it offered little information on the principal forests (the term forest is described by Morris, 1986, as a derivation of 'Foresta', land which lies outside the manor or vill) such as Wyre. However, a few written accounts, particularly that of Lea (1922), provided information on ownership and extent of Wyre forest during Medieval times. Records on the management of the forest during this period are even more scarce but it may be assumed that much forest management in Wyre was similar to that described by Linnard (1982), Peterken (1981, 1992), and Rackham (1980, 1986) for other regions of the British wooded landscape.

The management of the forest over the last 200 years is rather better documented by the Guild of St George (c.1930) and George (1987) and both these accounts are used as the primary source of information. To verify and support the written evidence from the two sources several taped interviews with Mr E.George were held in 1990. References were also made to the Forestry Commission Work Plan (Penistan 1963) to provide details on more recent trends in forest management in Wyre.

Field-based study

Recent developments in the field of woodland archaeology (Rackham 1986) have greatly advanced the current understanding of how forests were managed in the past. For this particular study an extensive perambulation of Wyre was carried out over Forestry Enterprise and NNR land to record as many archaeological features as possible associated with the historical management of the forest. These features, which included woodbanks, sunken tracks, saw pits, dew ponds and charcoal hearths, were recorded onto a 1:10 000 map. In addition a number of the saw pits, dew ponds and sunken tracks were measured to provide fuller information on these features.

Various studies on forest structure (Peterken 1981,1993) have provided evidence on historical management of old woodlands although this particular field of research has not been fully developed. For the purpose of this thesis a survey of the woodland structure was carried out to determine the extent and style of management practiced in the past. Based on observation four distinctive forest structural stand types were identified Within each of these stands representative quadrat sampling was then carried out. By the practice of Bunce and Shaw (1973), the size of quadrat employed was 200 m^2 (14.1m x 14.1m). Within the state-owned and NNR woodland a total of 87 of these quadrats were examined. However, the extent of the four stands in the forest varied considerably which affected the sampling strategy in the following way: A (high forest) - 35 quadrats; D (Traditional forest stands) - 35 quadrats; C (post clearance regeneration - 10 quadrats; and B (stored coppice stands) - 7 quadrats. Quadrats were distributed randomly within each example of stand type.

Only woody components (trees and shrubs) were recorded; any specimen below 1 m in height was ignored. The total number of plants of each species within a quadrat was noted and for each individual a record was made of diameter in centimetres at breast height (dbh). For coppice stools with multiple stems each stem was measured individually. The data were then arranged in dbh size classes for each stand. Finally, using the stem diameter/age correlation curves given by Salisbury (1925) and BTCV (1980), an estimation of the age of the different stands was made.

The data was analysed using three principal non-parametric tests: TWINSPAN ordination Hill (1979) to provide a classification of the forest structural-types; Chi-square analysis to provide significant proof of comparative measures of tree and stem density numbers between the various stands; and Mann-Whitney u test to determine the significance of the data collated from comparative measures of stem-size classes between the various stands. For suitably large data sets with insignificant differences in variance, the Student's t-test was used.

2.2.5 Initial survey of main forest habitats and vegetation patterns.

The aim of this study was to provide a detailed vegetation map and description of a representative area of the forest together with a comprehensive account of the status of key plant species and silvicultural plantations. Efforts were focused on Forestry

Commission land, and the area east of this which is designated NNR and SSSI.

The main habitats of the forest, e.g., pine, oak, birch woods, grasslands and wetlands, were recorded on to a 1:10 000 scale map. Furthermore, areas of vegetation which were distinguishable by eye by the predominance of one or two species were similarly mapped. The distributions of key species (those which were rare, uncommon or ancient woodland indicators - Peterken 1974) were also mapped. Mapping the vegetation on Forestry Enterprise land proved particularly arduous as there were more than 100 compartments to negotiate. To ensure that the vegetation was mapped accurately it was necessary to walk each compartment separately adopting the technique used for a PHASE II woodland survey (Kirby 1988). As part of the mapping exercise, a detailed plant list was compiled for each of the habitats identified.

2.2.6 A computer analysis of the plant communities and woodland stand-types.

The 1 m^2 quadrat surveys.

The aim of this survey was to analyse and compare, by means of Indicator Species Analysis (Hill, Bunce and Shaw 1975), plant associations for a number of woodland situations, including the plateaux, valleys and the eight different silvicultural stand types (TABLE 2.2.6.1). In each of these eight compartments (FIGURE 2.2.6.1) a 150 m long transect was marked out (the shape of the plantations dictated the positioning of the transects), and along each transect a total of thirty 1 m^2 square quadrats were sampled at five metre intervals. A further 74 quadrats were sampled, 30 over six wetland sites and the remaining 44 along a transect across the Seckley Ravine (refer to FIGURE 2.2.6.1), with the aim of getting a maximum range of vegetational states.

TABLE 2.2.6.1 The forestry plantations selected for the ISA study.

Compartment number	Woodland type	Summary description
1. 8059a (plateau)	Oak-beech, high forest, oak-1880, beech-1930	Extensive bare ground, *Holcus mollis* dominant field layer
2. 8064a (plateau)	Scots pine, planted in 1948	Heath-type community, *Pteridium* and *Vaccinium* dominant.
3. 8067a (plateau)	Oak high forest, singled in 1940	Heath-type community, *Deschampsia flexuosa/ Vaccinium* dominant.
4. 8068a (ridge)	Japanese larch, 1946, some oak	Heath-type community, *D.flexuosa/Pteridium* dominant.
5. 8070b (valley)	Oak high forest, singled 1880	Mixed herb, *Coryllus, Pteridium/Rubus* dominant.
6. 8077e (valley)	Corsican pine, planted in 1926	Mixed herb, *Rubus, Holcus mollis* dominant.
7. 8078b (valley)	Douglas fir, planted in 1926	*Rubus/H.mollis* dominant, ferns.
8. 8079j (plateau)	Douglas fir, planted in 1926	*Pteridium/Rubus/ H.mollis* dominant

For each sample the percentage cover was recorded as DOMIN values for vascular plant species. Non-vascular plants were not identified to species level but recorded as total percentage cover. A soil core sample was taken between 0-10 cm depth from the centre of each quadrat. Each soil sample was bagged and tested in the laboratory for pH after mixing with two parts water by volume.

The data was finally analysed through the ordination programme - Indicator Species Analysis (Hill et.al 1975). Floristic tables were also generated for the more important polythetic groups.

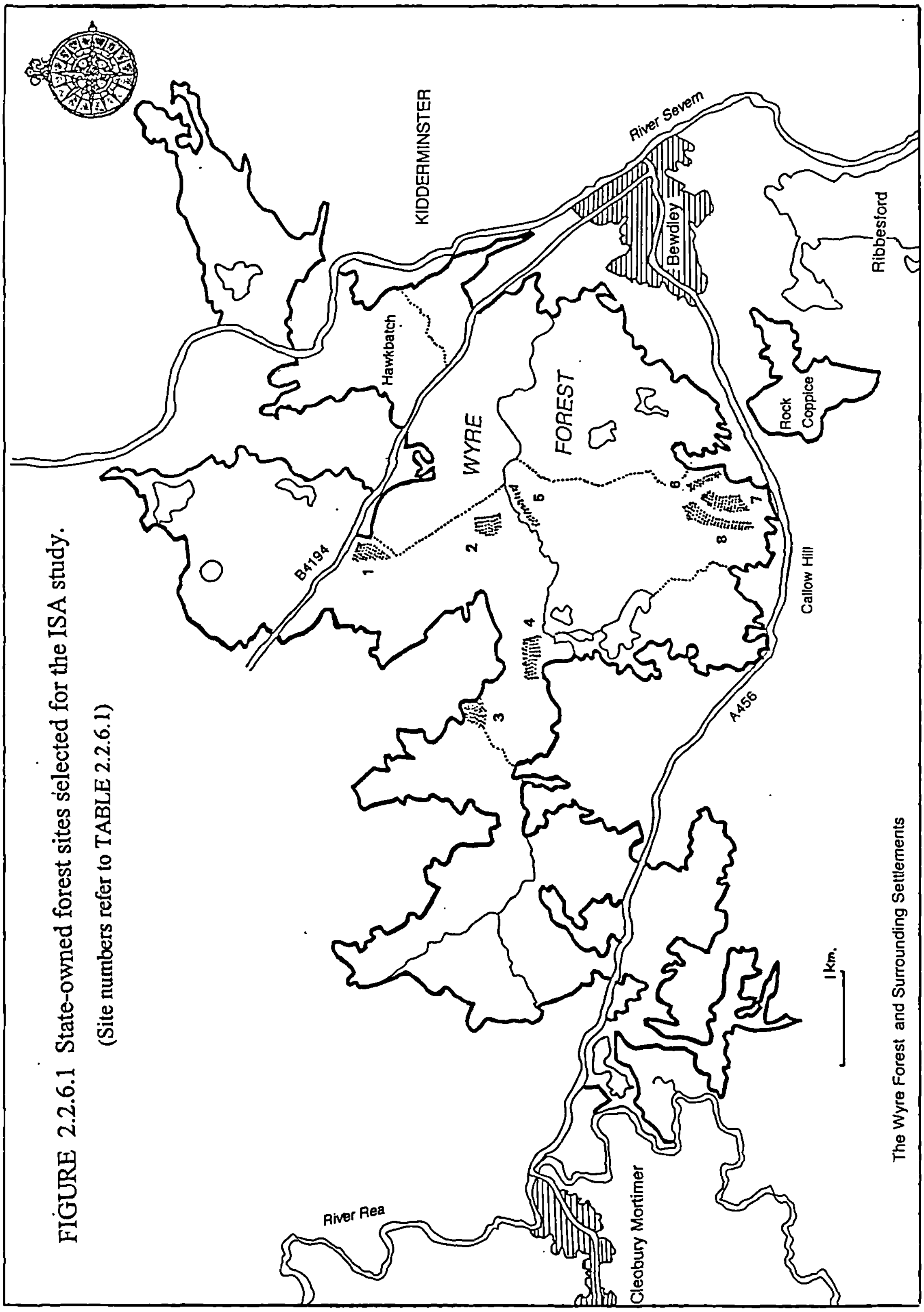


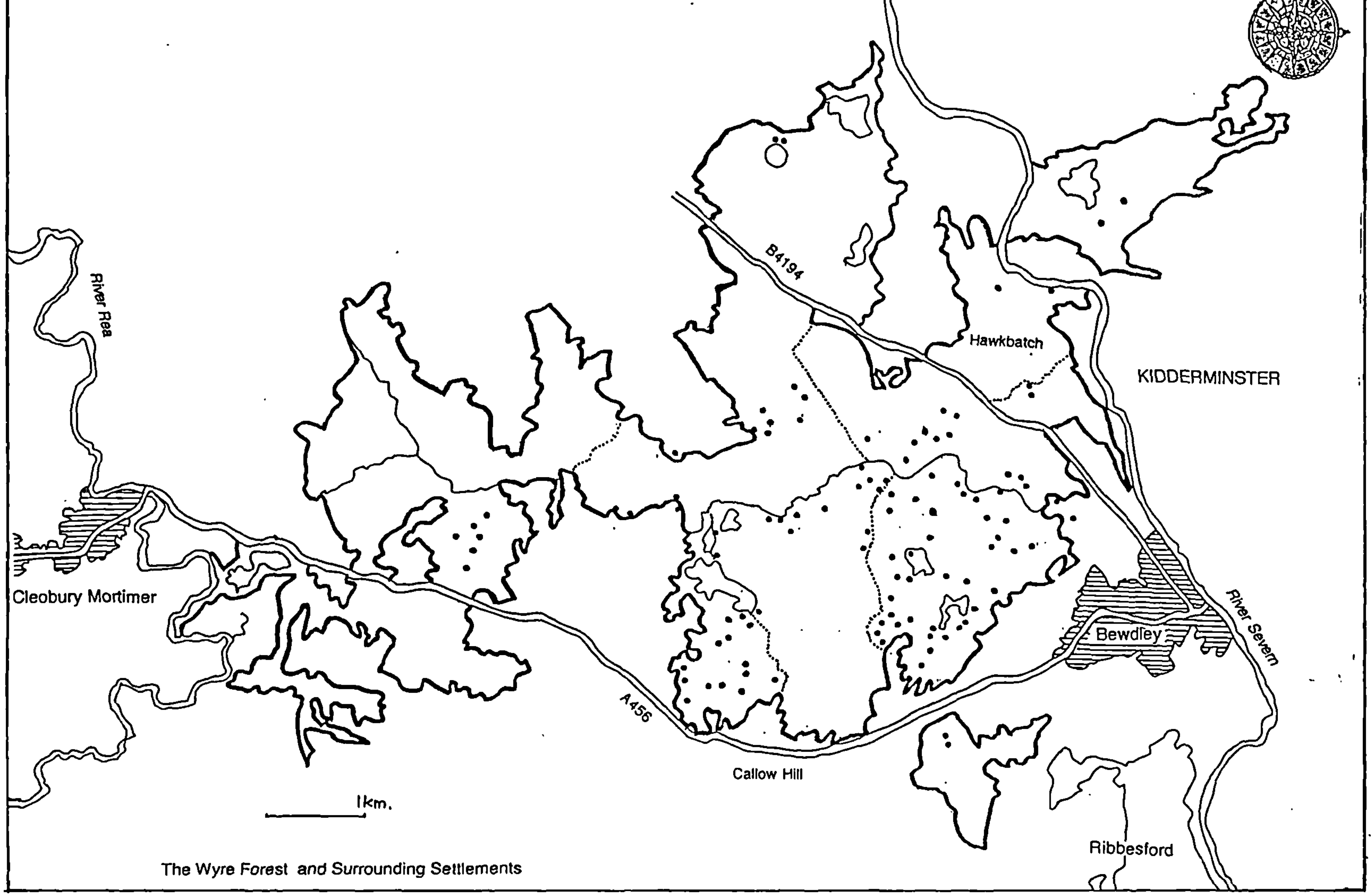
FIGURE 2.2.6.1 State-owned forest sites selected for the ISA study.

(Site numbers refer to TABLE 2.2.6.1)

The 4 m x 4 m quadrat field layer survey for the National Vegetation Classification

The phytosociological study of Wyre extended to all areas of ancient semi-natural woodland. The major woodland stand types were identified from earlier perambulations and using this information representative sampling of the vegetation was carried out. The technique of sampling adopted was that used for the National Vegetation Classification study (Rodwell 1991). A major problem arising was one of recognising and defining 'homogeneous vegetation', a concept which has been extensively researched and also criticised for being open to subjective interpretation (Hill 1979, Causton 1988). At Wyre several species had almost constant presence in the vegetation whilst other species varied in frequency and abundance. Species which occupied a dominant or abundant (based on the DAFOR ranking order) status within a vegetation stand were considered to form the constants in that community and probably gave the best way of representing broad stand-types. This method took into account less obvious changes in species composition in the presence of constants and allowed for what may be regarded as sub-communities. Once a homogeneous stand had been identified, a nest of three different sized quadrats were used for sampling at each site. To record canopy cover a 50 m x 50 m plot was used; for scrub or understory, 10 m x 10 m; and for fieldlayer, 4 m x 4 m. In all, 109 such samples were recorded across the forest (FIGURE 2.2.6.2) taking into account all woodland stand types. For each sample plot the percentage cover of the plant species identified was recorded. These values were represented as DOMIN readings for analysis. The survey was carried out during the optimum flowering period May to June. The analysis of these data was carried out using two techniques: TWINSPAN, after Hill (1979) - a polythetic divisive method of analysis, and MATCH (Malloch 1990) - a Correlation Coefficiency which matches observed data against NVC communities. Floristic tables were generated for the more important polythetic groups.

FIGURE 2.2.6.2 Distribution of the NVC quadrat samples, Wyre :



Finally, to ensure that a more complete description of the ecology of the forest was provided for the necessary criteria by which an evaluation could be made for the conservation management prescriptions data from several other studies were used. These included the following research projects:

An investigation of the infestation of oak by *Kermes quercus* (a long term monitoring programme, Hobson and Bultitude, Otley College);
An assessment of deer damage (Hobson and Bultitude, Otley College);
The long term monitoring of vegetation recovery in closed coppice coupes (Hobson and Bultitude, Otley College); and
The distribution and colonization patterns of *Formica rufa* in Wyre Forest (Hobson and Bultitude, Otley College)

All these studies have been carried out over a period of three years using detailed quantitative sampling techniques. Furthermore, the data has been analysed statistically.

C H A P T E R 3

THE GEOLOGY AND CLIMATE OF WYRE FOREST

3.1 INTRODUCTION

A number of surveys of the soils of Wyre have been carried out by different authors including Mackney and Burnham (1964), although much of the credit goes to Penistan (1963), and Oliver and Webster (1987) and Oliver (1995) for the most comprahensive studies to date. These last two authors present a picture so complex that it is clear that a detailed map of the forest soils would be very difficult to construct.

The present investigation does not attempt to add new information regarding the geology or soils of the forest; rather, it draws on all available records to provide as complete a picture as possible. However, quadrat sampling during surveys of the forest vegetation has provided valuable data on the pH values for both plateaux and valley areas. This chapter also deals with the local climate of the forest, using information from a local weather station based at the Wyre Forest office, Callow Hill.

3.2 GEOLOGY AND SOILS

It is generally accepted that Wyre Forest was saved from the plough by virtue of its inhospitable geology and soils. One of the characteristic features of Wyre is the very intricate spatial pattern of soil variation; indeed Oliver and Webster (1987) considered that a sampling interval no greater than 20 m was required if the soils of the forest were to be mapped accurately. This variation results from the alternating outcrops of Carboniferous sands and shales which give rise to a complex patchwork of sandy and clayey soil. The geological history of Wyre is briefly described below.

3.2.1 The Geology of the Forest

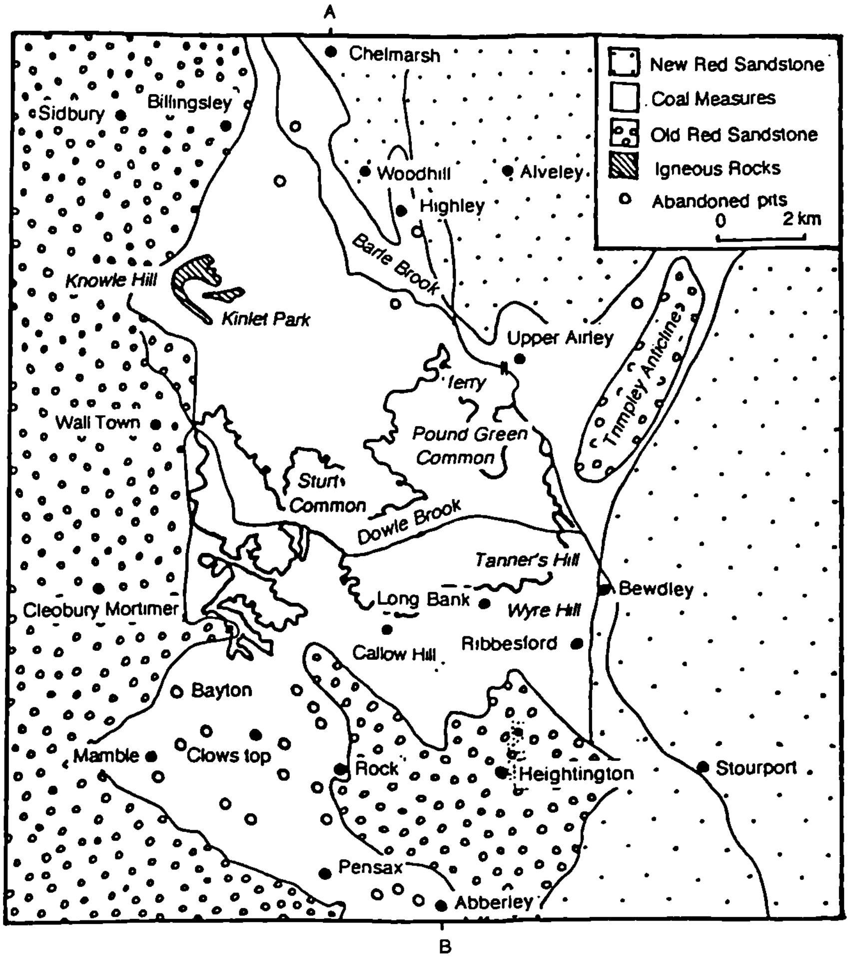
The geological landscape of Wyre is the result of the culmination of three major events: the sedimentary processes of the Carboniferous with its great forests and swamps; a much later period of unrest during the Permian which left the bedrock jointed by fault lines; and finally various Ice Ages followed by the Flandrian Interglacial and the onset of the Quaternary Ice Age.

The bedrock formations underlying Wyre are part of the extensive Staffordshire Coal Fields (FIGURE 3.2.1.1), deep Carboniferous deposits dating back 350 million years. Over 90% of the soils of Wyre are derived from rocks of the Upper division of the Carboniferous system - the Productive Coal Measures and the Upper Barren Coal Measures. This latter formation is made up of the Old Hill Marl and the Highley Beds. The Old Hill Marl is by far the most extensive formation in the forest (Oliver 1995), and the two components of this formation are Etruria Marl and `esplay' sandstones. The latter are characterised by the presence of flaggy, angular pebbles which can be seen on most deep road-cuttings and, more unusually, on small knolls scattered throughout the forest (FIGURE 3.2.1.2).

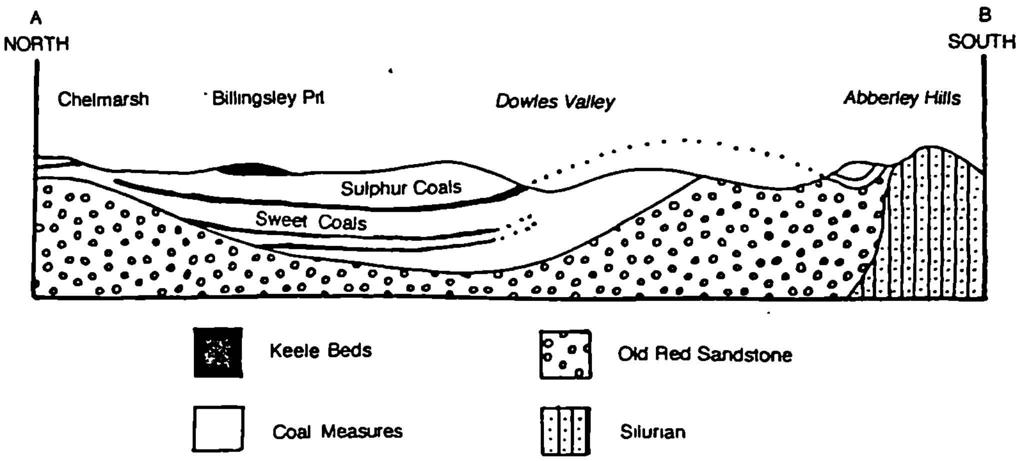
The Highley Beds are lithologically distinct from the Old Hill marl and consist of sandstones and grey shales. The noticeable lack of coal seams in much of the forest is attributed to the environmental conditions which prevailed at that time. Much of the landscape was submerged under a large delta system which accounts for the complex horizontal banding of sandstone and shale. The deltaic conditions then also explain a certain uniformity in character of rock (Penistan 1963). This is borne out by three main features: the fine-grained nature of the rock; the uniform lithographic character of each bed; and finally all the rocks are non-calcareous (Penistan 1963).

The sandstones are yellowish-olive, often with bands of manganese staining. The more extensive beds of shale are sandwiched between

FIGURE 3.2.1.1 a) A simplified geology of the region around Wyre Forest.

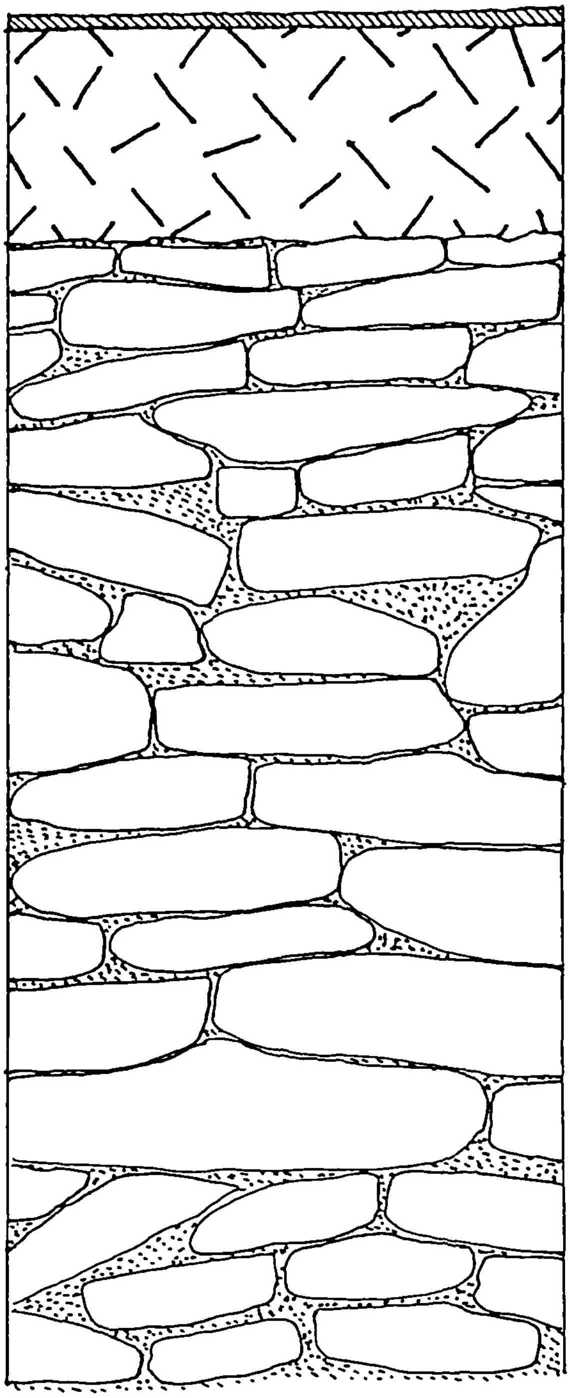


3.2.1.1 b) Geological cross-section from Chelmarsh in the north to Abberley Hills in the south through Wyre Forest.



A Simplified Geology of southern Shropshire

FIGURE 3.2.1.2 Soil profile overlying the Old Hill marl beds which shows the flaggy sandstone.

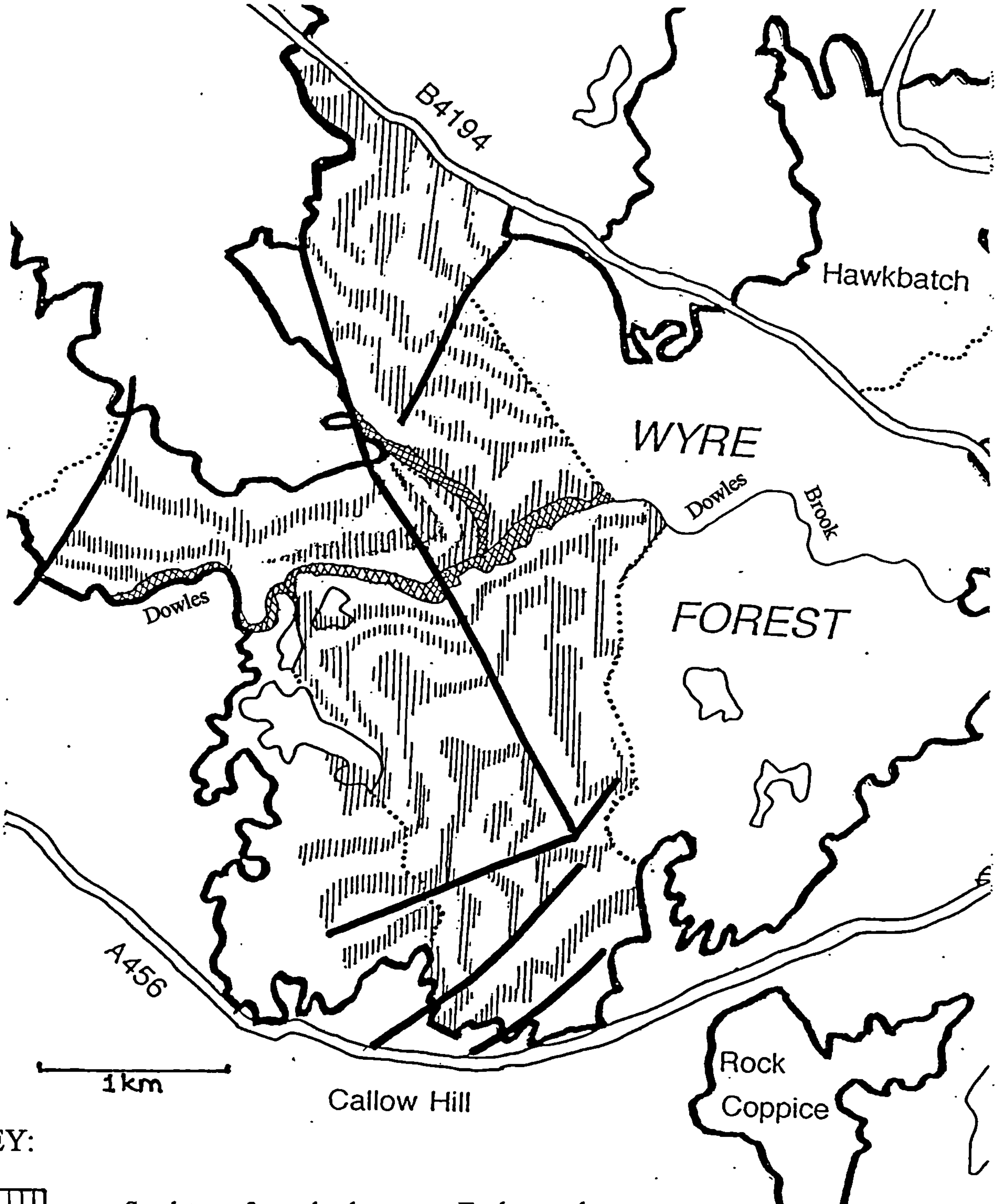


the sandstone producing distinctive horizontal beds. The shale commonly contains large numbers of fossils including Lycopsids e.g. *Lepidodendron,* Sphenopsids, e.g., *Calamites* and *Annularia,* and fern-like plants, e.g., *Neuropteris.* Following the Carboniferous age there was a period of active movement and folding of the rock, particularly during the period of intense mountain building in late Permian times. This activity also created numerous faults in the bed-rock (FIGURE 3.2.1.3). There are more faults to the south of the Dowles Brook than to the north and these south-of-Dowles faults exhibit a SW - NE trend, whereas to the north it is more N - S (Oliver 1995). The geological pattern within the forest is controlled more by physiography and faulting than by folding. This more recent activity largely explains the complex soil pattern within the forest, and also, according to Penistan (1963), complicates relationships between topography and geology.

During the last Devensian Ice Age there were three main glacial advances towards Wyre Forest. The nearest glacier which covered the eastern part of what is now Wyre advanced from the east and north, the Eastern and Pennine ice. To the north and west the Irish and Welsh ice sheets encroached on to Clee Hill without advancing further. The ice sheets with their characteristic 'creep' and hill-wash effect caused the translocation of material including conglomerates and 'foreign' pebbles from as far as north England, Scotland and Northern Ireland.

The other major impact on the local landscape as a consequence of the Ice Age was the change in course of the River Severn which cut scarps 60 m deep into the plateau landscape as it flowed towards the Bristol Channel. The scouring effects of the river affected the whole drainage system of the forest causing gully erosion along the Dowles, Mudder and Park brooks. This change in pattern of regional watershed coincided with the melting of the ice sheets during the Quaternary Period.

FIGURE 3.2.1.3 Geological map of the state-owned portion of Wyre Forest



KEY:

Sandstone & sandy clay, some Espley sandstone

Clay & Shales

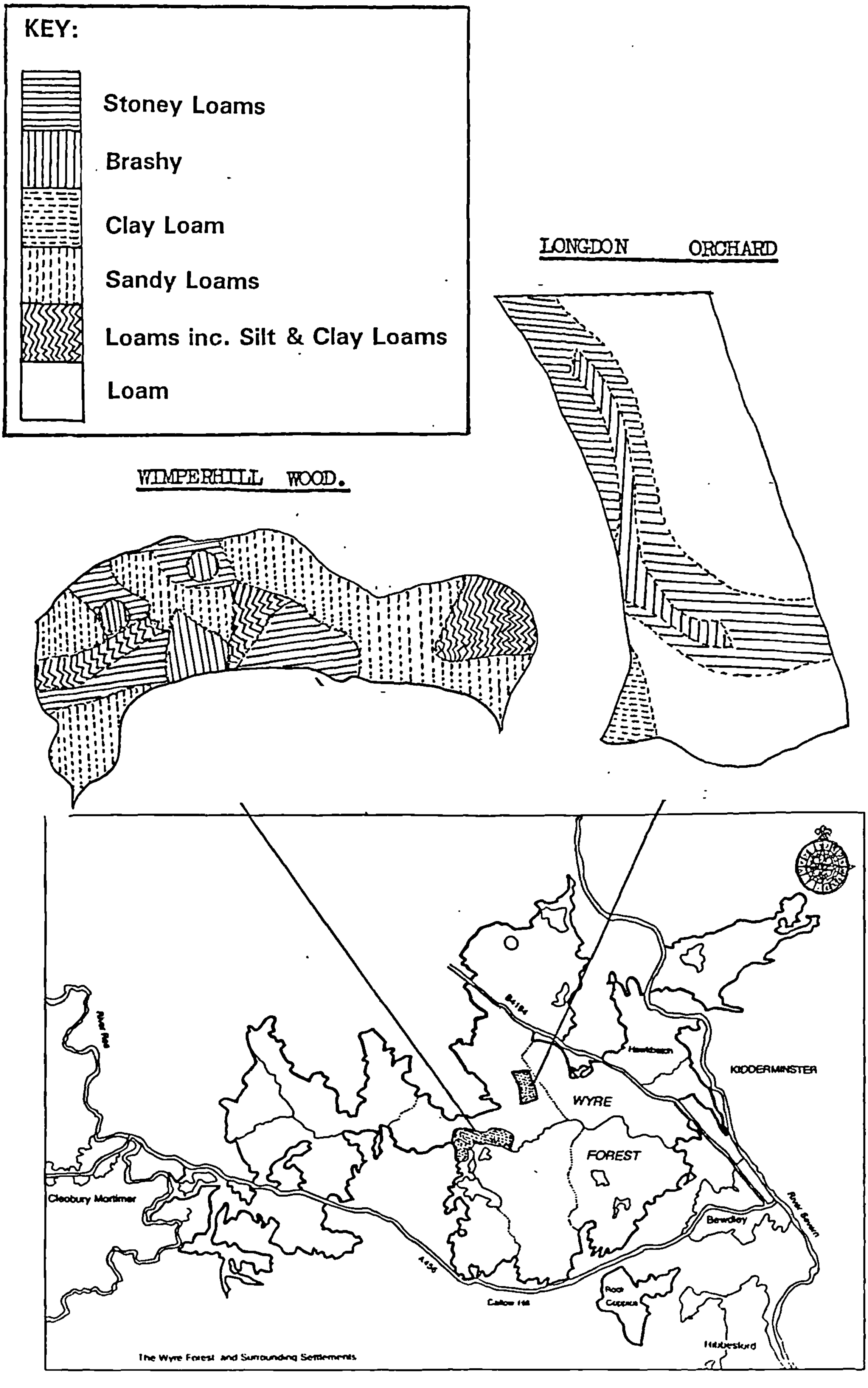
Alluvial deposits

Fault lines

3.2.2 The soils of Wyre

The soil map of Wyre Forest produced by Pocock in 1947 indicated a complicated pattern related to the topography. However, these findings were contested by Penistan (1963), after carrying out a detailed soil survey of the forest. The latter study showed that soil patterns were a reflection of the conditions and manner of the formation of the underlying rocks and were not so much influenced by topography. Mackney and Burnham (1964) described two types of soil, with pH ranging from 4.0 and 7.0. One was a surface water gley of which the upper 35 cm was well drained, with a loam or sandy loam texture and stony, whilst below there was clay resulting in impeded drainage and mottling. The other was an Acid Brown Earth, leached, well drained, stony and of loamy texture. Penistan's geological survey of 1960 also revealed the spatial complexity of soils throughout the forest (FIGURE 3.2.2.1), a feature which was confirmed in a more detailed study on soil patterns by Oliver and Webster (1987), and Oliver (1995). Oliver has also shown that spatial variation in the sub-soil appeared to increase with increase in depth, in other words, the soils were more varied when considering the variation from place to place of the subsurface rather than the surface layers. Contrasts in the parent rock and periglacial disturbance of the soil during the Pleistocene were probably the main contributors to the variation (Oliver and Webster 1987). In general the average range of spatial variation of the soil properties was 45 m which correlated with the average spacing between lithological boundaries. However, Oliver (1995) maintained that a considerably shorter spacing of 20 m would be necessary to map the soils of Wyre effectively. The same cannot be said for variations in soil pH; that of the topsoil was more variable than that of the subsoil. This was probably a result of the uneven distribution of rainfall and dissolved anions in it after passing through the tree canopy (Oliver and Webster 1987). The frequent occurrence of *Calluna vulgaris* and *Vaccinium myrtillus* around the bases of trees in an otherwise bramble/softgrass/bracken-dominant vegetation added support to

FIGURE 3.2.2.1 A lithographic map of Wimperhill (SO7376) and Longdon Orchard (SO7477). Taken from Penistan (1963).



this statement. Past management has also had a considerable effect on soil pH. Coppicing over centuries has impoverished the soil by removing minerals and so producing an increasingly acidic soil (Oliver and Webster 1987).

The soils were generally acid brown earths with or without gleying at depth according to the amount of sandstone in the drift, and the compaction of clay loam. The accumulation of humus was very localised and for the remainder of the forest organic matter appeared to be actively breaking down. There was an apparent absence of worms to work the surface humus into the mineral soil. On the higher ground the mean pH value was $3.77^{+0.04}$ (taken from 120 samples), while on the lower hill slopes the mean value was $4.68^{+0.04}$ (taken from 90 samples, pH values are given in the Appendix 6.2.1). Whilst the general understanding is that conifer trees lead to a gradual acidification of the soil this was not reflected in the results of the soil pH testing in both broadleaved and coniferised areas of Wyre. The following table records the mean pH values for each of the eight plantations surveyed during the ISA study..The table also includes, for comparison, pH values recorded for similar stand types in Wyre by Brown in 1979 (Fieldhouse 1982).

PLANTATION (30 samples in each case)	MEAN SOIL pH VALUE AT 0 - 10 CM	MEAN SOIL pH VALUE, 0-5 CM (Brown 1979)
1. 8059(a), oak/beech	$3.65^{+\ 0.065}$	-
2. 8064, plateau pine	$4.05^{+\ 0.032}$	-
3. 8067(a), plateau oak	$3.81^{+\ 0.09}$	4.2
4. 8068(a), Ridge larch	$3.84^{+\ 0.032}$	4.1
5 8070(b), valley oak	$4.75^{+\ 0.082}$	4.8
6 8077(e), valley pine	$4.96^{+\ 0.130}$	4.6
7. 8078(b), valley D.fir	$4.3^{+\ 0.117}$	4.6
8. 8079(j), plateau D.fir	$3.71^{+\ 0.22}$	4.1

It is possible that the impact of conifer trees on existing low base-status, partially leached forest soils was only marginal, and that it was more than likely that any significant change to the soil had already occurred as a result of past management activities, namely, intensive coppicing. However, a previous study on the soils of Wyre by Fieldhouse (1982) suggested that in a situation where oak had been underplanted with beech in the 1930s the soil organic content had significantly increased over a 50 year period and with time the pH value would be expected to increase accordingly.

It is likely that the variation in soil type is also manifested by extreme changes in topographical conditions. On the slopes of stream valleys Penistan (1963) observed varying patterns of clay and sandy soils brought about by localised landslip. The litter layer and organic component of soil may also vary on account of slope and as much as 40% of mid-slope litter may accumulate as a result of downslope movement (Orndoff and Lang 1981). Deeper litter also tends to build up at the top and bottom of slopes as well as around the base of trees (Ovington 1964). These factors can result in litter layers of depths eleven times greater than average (Orndoff and Lang 1981). These findings were supported by the results of the study carried out in Wyre by Fieldhouse (1982). The field layer under an oak canopy can also have a noticeable effect on the organic content of a woodland, contributing 4% of the total litter layer (Sydes and Grime 1981). Bracken and heather are especially effective at trapping litter (Sydes and Grime 1981) and on those sites in Wyre which had comparatively deep litter layers both heather and bracken were prevalent (Fieldhouse 1982). In Wyre the soil zones were not so clearly defined into organic and mineral layers. However, in order to generate a description of a soil profile for the purpose of this study a perfunctory investigation of the soil was carried out which involved taking measurements of the litter layer; fermentation layer; and humus layer (see below).

Litter layer:	Mean value (cm): Range (cm):	1.30 0.1 - 3.9
Fermentation layer:	Mean value (cm): Range (cm):	0.8 0.0 - 2.8
Humus layer:	Mean value (cm): Range (cm):	0.4 0.0 - 3.2

(Values calculated from 80 samples taken from 8, 200 m^2 quadrats using a random sampling method).

The various studies undertaken in Wyre (Penistan 1963; Oliver and Webster 1987, Oliver 1995) portrayed a very complex soil pattern for Wyre forest, and it was suggested that there were four principal local factors contributing to the edaphic landscape of Wyre:

a) the underlying geology (as demonstrated by Penistan 1963 and Oliver and Webster 1987, Oliver 1995);

b) topography and geomorphology (Salisbury 1925, Penistan 1963);

c) vegetation types;

d) past and current management.

It is worth exploring a number of these points. There were many examples throughout the forest of apparent differences in soil conditions as a result of geomorphological features. For example, old woodbanks which cut through vegetation described in the NVC (Rodwell 1991) as W10 oak woodland stand-types frequently supported a more calcifuge community which was abundant in *Deschampsia flexuosa* and *Vaccinium myrtillus.* The vegetation pattern reversed where there were deep woodbank ditches. For rather the same reasons old dew ponds and saw pits often supported a reasonably herb-rich community dominated by *Rubus fruticosus* agg. and *Holcus mollis* which, in some locations, provided a sharp contrast with the surrounding vegetation more typical of a community described in the NVC as W16 stand-type. These very localized vegetation patterns were often repeated within the coniferised areas of the forest where wind throw had produced a pit-mound sequence throughout a plantation (Hobson 1992).

Modern harvesting practices were also observed to have brought about an apparent change in the vegetation. Where tractors had cut through the top soil layer and exposed the rather more sandy-clay subsoil the change in soil conditions had favoured bramble in an otherwise bracken-dominant vegetation.

Coppicing has also left its mark on the edaphic landscape. Throughout stands of oak-bracken-bramble woodland the forest floor were peppered with old coppice stools, some still with growth, others which were derelict. Many of these larger stool mounds supported a heathy association of *Vaccinium myrtillus, Deschampsia flexuosa* and *Galium saxatile.*

The soils of Wyre Forest can be grouped into a number of types based on several characteristics. In his survey, Penistan (1963) recognised 5 major categories based on the proportions of the various particle sizes: Brashy types; Sandy loams; Clay loams and Clays; Stony loams; and Loams and Silty loams.

1 Brashy types

Brashy soil is derived from coarse-grained sandstone which has broken up into flaggy tabular blocks. The broken coarse-grained sandstone blocks are usually 6" - 12" across, 1" - 2" thick with the longer face along the bedding plane, sometimes horizontal but usually tilted slightly. There is a minimum of mineral soil between the sandstone fragments and that consists of a gritty sandy loam. These soils have a loose constitution and are excessively drained, offering tree growth a limited area of mineral soil from which nutrients can be readily extracted. The conditions of excessive percolation result in the loss of soil moisture, the leaching of bases (apparent by the dominance of *Calluna vulgaris, Deschampsia flexuosa* and *Vaccinium myrtillus*), and the mechanical eluviation of part of the clay fraction from the mineral soil component in the upper part of the horizon, which is redeposited lower down. Brashy soils are most commonly a feature of ridges, peaks of hills and knolls. Plants most commonly associated with brashy soils in order of dominance are: *Calluna vulgaris, Deschampsia flexuosa* and *Vaccinium myrtillus.*

A typical profile of brashy soils is:

HORIZON	DEPTH	DESCRIPTION
F	surface	Almost imperceptible oak leaves, dead vegetation
H	surface	Faint black staining on surface of mineral soil.
	0 -5"	Medium brown sandy/loam, coarse grained sandstone up to 6" across. Fine crumb structure, very porous, many roots, free rooting medium.
	5 - 17"	Orange-brown sandy loam, coarse-grained sandstones angular and shaley, 6-9" across, 1 - 2" thick. Mineral soil has a fine crumb, free rooting.
	17 - 21"	Yellow-brown stony, sandy loam, much more sandstone fragments, gritty, sandy loam between fragments but includes higher clay fraction than above
	>21"	parent rock, tabular & shaley sandstone, some roots at 30"

2 Sandy loams

Sandy loam is a light-textured, deeper soil with a proportion of stone. It is usually associated with lower slopes of hills. Plants most commonly associated with this soil type in order of dominance are: *Deschampsia flexuosa, Holcus mollis, Lonicera periclymenum. Pteridium aquilinum, Rubus fruticosus agg., Vaccinium myrtillus.*

A typical profile of sandy loam is:

HORIZON	DEPTH	DESCRIPTION
F	0 - 1/4"	Leaves and detritus.
H	1/4 - 1/2"	Black amorphous humus, greasy
	1/2 - 11/2"	Dark medium loam, good crumb. Finely porous. some organic matter from above.
	11/2 - 7"	Orange/medium brown, medium-grained sandy loam Crumb/nutty, coarsely porous.
	7 - 34+"	Yellow brown sandy loam. Sandstones frequently 1/4 - 2" across. Good crumb, coarsely porous

3 Clay loams and Clays

Both of these soil types frequently form the subsoils of many of the other types. However, clay loams and clays may possess a considerable sand and silt fraction although samples tested in the laboratory showed a clay fraction of 50% (Boats 1960). Clays are frequently associated with wetland flushes, springs, water-filled ruts and puddles. Often these areas support a diversity of plant life indicative of wetlands and more base-rich soil, for example, *Carex* spp., *Juncus* spp., *Brachypodium sylvaticum, Deschampsia cespitosa and Euphorbia amygdaloides, Filipendula ulmaria, Primula vulgaris and Rosa canina.*

4 Stony loams

Stony loams are probably the commonest soil type in Wyre covering up to 40% of the forest. The mineral soil is light textured, sandy or sandy/clay loams with a high proportion of stone. The vegetation is similar to that of sandy loams but with a higher proportion of *Deschampsia flexuosa*, *Holcus mollis* and *Vaccinium myrtillus.*

A typical soil profile is:

HORIZON	DEPTH	DESCRIPTION
F	0 - 11/2"	Detritus.
H	11/2-13/4"	Black amorphous humus.
	13/4 - 36"	Medium brown sandy to medium loam, very stony, sandstones angular, sometimes rounded. Fine crumb, very porous, loose and friable.

5 Loams and silty loams

Loams and silty loams occupy about 25% of the forest area. They are fairly deep, well drained and often on flat or gently sloping ground. The dominant vegetation is *Holcus mollis, Pteridium aquilinum* and *Rubus fruticosus* agg.

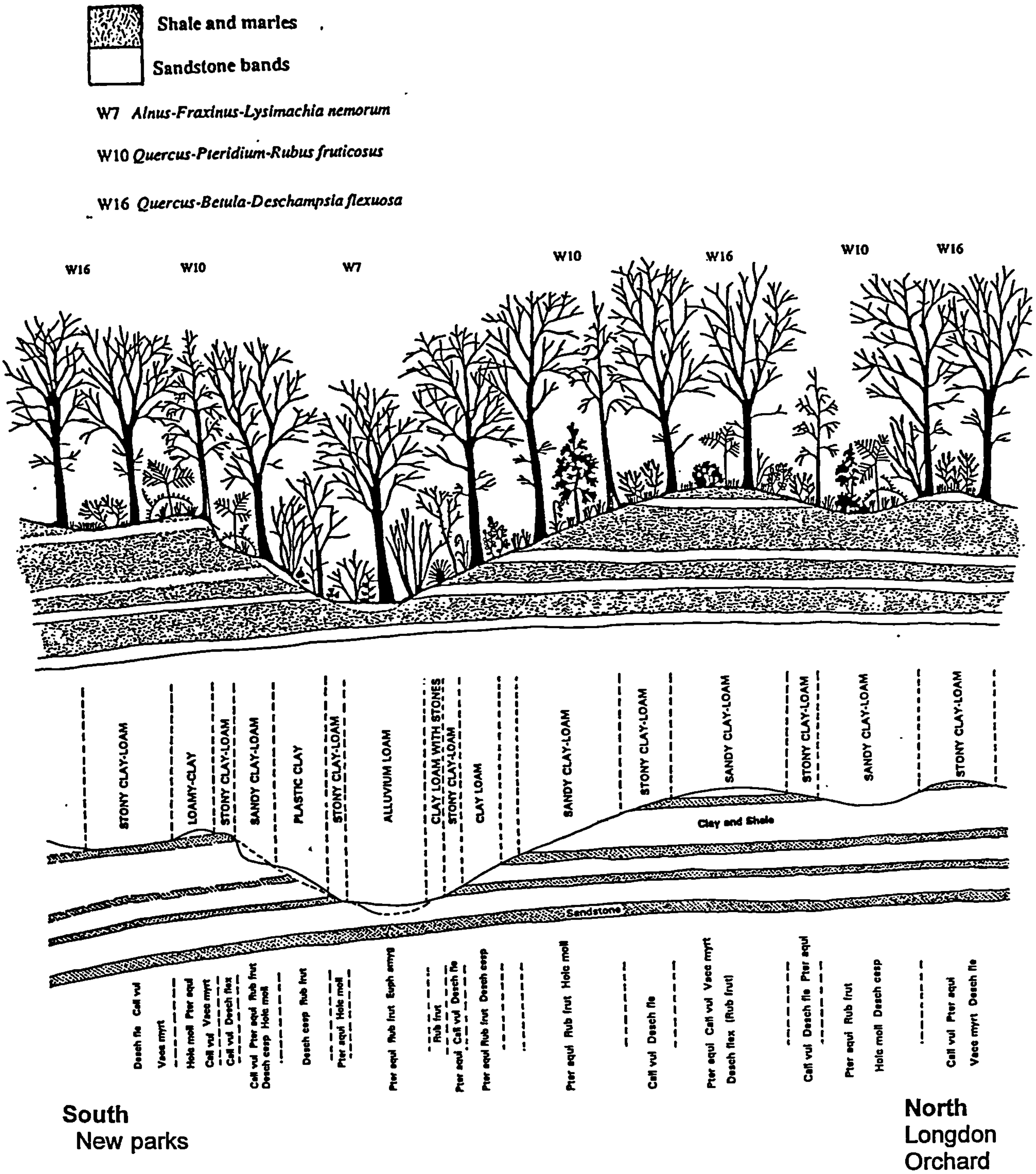
A typical profile of silty loam is:

HORIZON	DEPTH	DESCRIPTION
F	0 - 1"	Detritus, oak leaves
H	1 - 11/2"	Black amorphous humus
	11/2 - 2"	Dark-brown medium loam, good crumb, sandstones occasionally to 1/2" diameter. Intimate mixture of humus throughout.
	2 - 5"	Medium-brown sandy loam good crumb, sandstones occasionally to 2" diameter, porous.
	5 - 11"	Orange-brown silty loam, good crumb, porous.
	11 - 40"	Yellow-brown mottled red-brown sandy silty loam, good crumb. Porous, no humus.

One other category should be added to this group to complete the series in Wyre Forest, that is the Alluvial Deposits which are confined to small strips along waterways such as Dowles, Park and Mudder brooks. They are typically fine, deep silt deposits with little stone content. The dominant vegetation frequently includes *Allium ursinum, Deschampsia cespitosa,* and *Lamiastrum galeobdolon.*

Penistan (1963) after detailed consultation with Mackney and Burnham (authors of the Soil Survey of England and Wales) maintain that a rough idea of soil distribution can be formed from knowledge of the out-cropping of the Coal Measure sandstone which weathers down to a stony soil, while other formations weather to a clay loam. The stony soil is visible only in parts of the forest where it forms a tump, ridge or step in a slope. The geology may be considered a sandwich of sandstones and clays (FIGURE 3.2.2.2). On steeper slopes landslips and colluvial drift give a general mixture. All the soil types have a number of characteristics in common. They can be defined as being slightly leached Brown Earths and typically possess mor or moder humus on the plateau, though mull is not uncommon in ravine soils (Packham 1975). They are markedly acidic as a result of the deficiency of bases in the parent rock although there are clear distinctions between plateaux and valleys. Recent silvicultural practices have also had local effects on the soil. Where oak woodland has been underplanted with beech the organic content in the soil is significantly greater 40 years on from the first plantings (Fieldhouse 1982).

FIGURE 3.2.2.2 A diagramatic section of main block Wyre Forest showing incidence of soil and vegetation as influenced by geology and topography (modified version of Penistan's diagram 1963).



3.3 THE CLIMATE OF WYRE FOREST

The climate for the area around Wyre is typical of the English Midlands and is as little influenced by maritime conditions as is possible in this country. It is characterised by comparatively low rainfall and relatively high temperatures in the growing season.

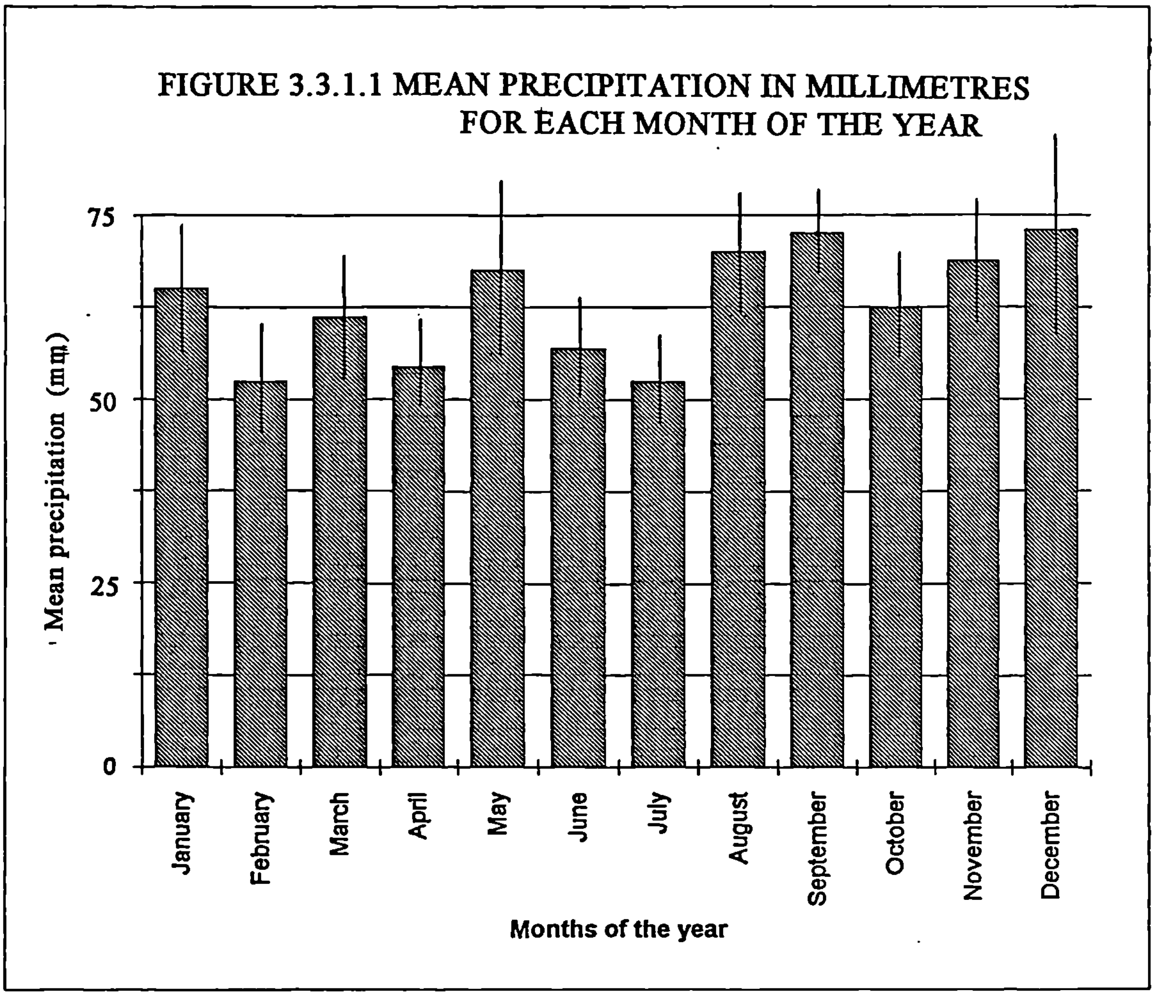
3.3.1 Precipitation

There were two sources of data on precipitation for Wyre Forest; these were: records taken at Bewdley between 1910 and 1960 (taken from the Wyre Forest Work Plan, Penistan 1963); and records made between 1963 and 1986 at the Callow Hill Forestry Office (data unpublished). The average annual rainfall recorded for Bewdley between 1910 and 1960 was 697.5 mm (the town is 3.2 km from the forest and 105 m lower in elevation. More recent records taken in the forest between 1963 and 1986 indicated an average annual rainfall of 775 mm (recordings made at Wyre Forest by the F.C).

The average precipitation values recorded for the summer months for South Shropshire, which is similar to Wyre Forest in elevation and terrain, are shown in the following table:

April	May	June	July	August	Sept.	Total
51.2	78.7	88.7	90.0	76.2	41.2	426

(values in millimeters, taken from Penistan 1963. The period of time covered is not stated). FIGURE 3.3.1.1 shows the mean precipitation values taken over 25 years for each month for Wyre Forest. The readings were taken between the years 1963 and 1986. Work by the Ministry of Agriculture, Fisheries and Food suggested that for Worcestershire potential evapo-transpiration was higher than the average precipitation during the summer months, five years out of ten, so that during the growing season root crops were



Values are calculated from readings taken over a period of 25 years (1960 - 1985) drawing on winter reserves of moisture (Penistan 1963). Rainfall in Wyre Forest was significantly higher than the average precipitation levels for the County and tree roots cannot be compared directly with the roots of agricultural crops, but it was clear that moisture could be a limiting factor for some species. The precipitation- evapotranspiration deficit was more than 10 cm in Worcestershire (Penistan 1963) which may bear this out. The low humus content of many forest soils can only exacerbate the problem.

3.3.2 Temperature

There has been very little work done on the recording of microclimatical conditions in Wyre Forest and consequently there is a paucity of information on local temperature conditions. However, for the purpose of this study temperature readings were taken for the year 1989 (TABLE 3.3.2.1). Crops in the Vale of Evesham, 26 km south of Wyre are amongst the earliest to start growing in the British Isles, but Wyre uplands are fully two weeks later than them.

The considerable variation in forest structure and habitat-type has a profound effect on microclimatical conditions in Wyre (Leek 1988). On dull cloudy days the diffuse radiation skylight incident at the surface was so low as to barely penetrate the forest canopy of young Douglas fir plantations. Consequently little incident energy was available within the plantation (Leek 1988). Also during these periods of bad weather the atmosphere in these plots was saturated, particularly at times of low wind. This moisture condenses under the cool conditions and promotes the release of latent heat energy. It was observed that this release of energy did, to some extent, warm the air in the absence of incoming solar radiation (Leek 1988). The situation was very different in open areas of the forest such as the forest rides and glades. The influx of solar radiation represented the largest energy component in the environment. There was also considerable energy used up in free evapo-transpiration on these open sites (Leek 1988).

TABLE 3.3.2.1 The mean temperature readings for each month for 1989.

MONTH	MEAN TEMP. (centigrade)	MEAN MIN. TEMP. (centigrade)	MEAN MAX. TEMP. (centigrade)
January	7.9	-4	12
February	8.5	-4	13
March	10.7	-5	16
April	10.9	-2	14
May	18.5	1	24
June	20.1	2	28
July	23.4	6	29
August	21.8	7	25
September	18.1	2	23
October	14.0	1.5	18
November	6.7	-6	14
December	8.9	-2	14

3.3.3 Wind factor

Wind characteristics have been recorded for Worcester (FIGURE 3.3.3.1). Serious windblow problems are very sporadic and infrequent in Wyre, though there are records of serious windblow in 1924 and 1953. One record from 1600 stated that a tempest blew down "near 1000 oak in Wyre and Horton wood". More recently, gales up to 73 knots were recorded during 1976, 1987 and 1989/90 (FIGURE 3.3.3.2). Most of the damage in Wyre, whilst small compared to other regions (Mortimer Forest), was focused primarily in conifer plantations, over 2000 trees were blown down by the 1987 storm in contrast to just over 15 oak trees. In 1989 the 29-stem Seckley Beech, an historical landmark which stood over 70 feet high, was also brought down by the storm (FIGURE 3.3.3.3).

3.3.3.1 The average number of days on which the wind blows from each quarter.

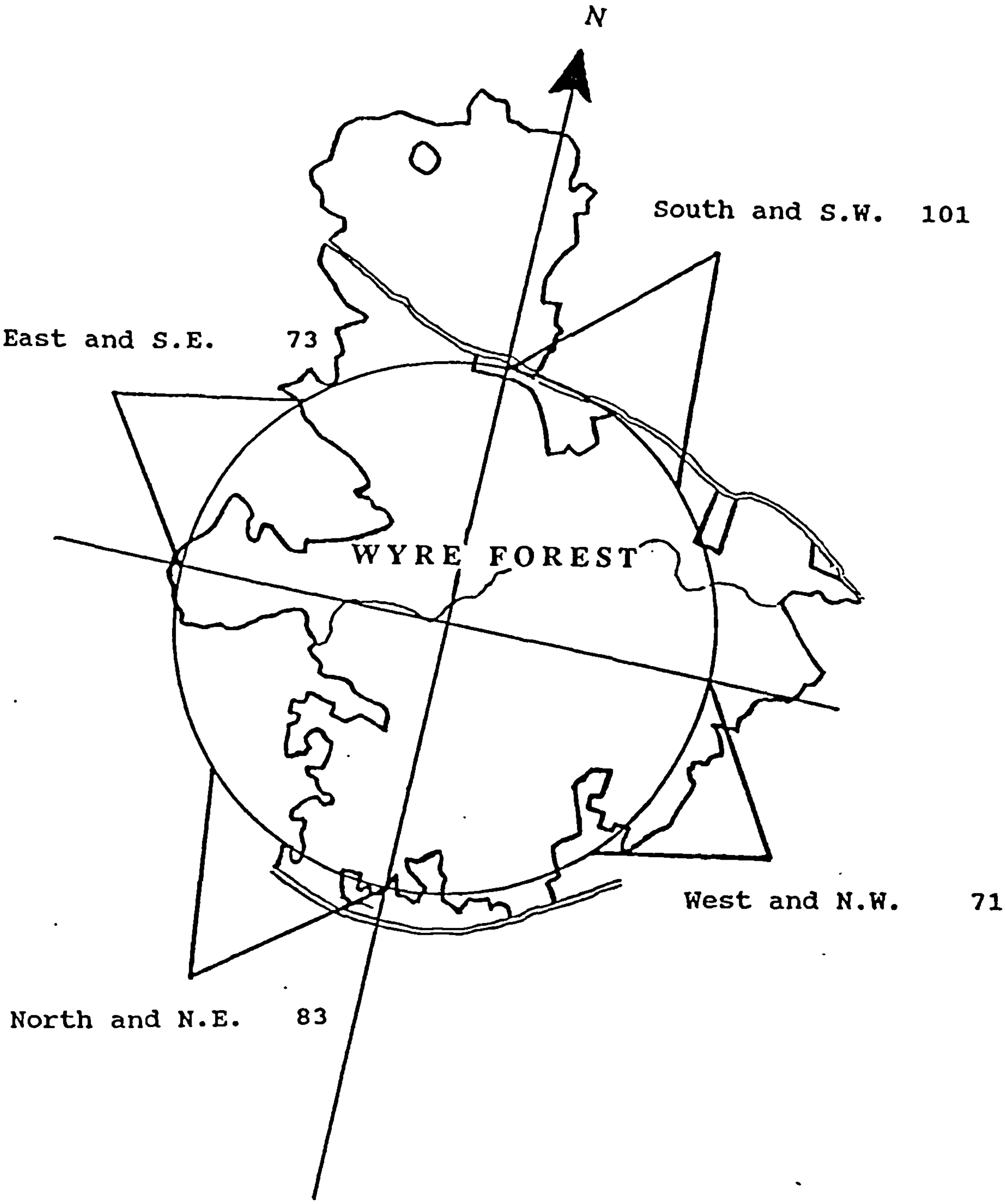


FIGURE 3.3.3.2 Figures of wind speeds (in knots) for three gale years (taken from the Forestry Commission 1990).

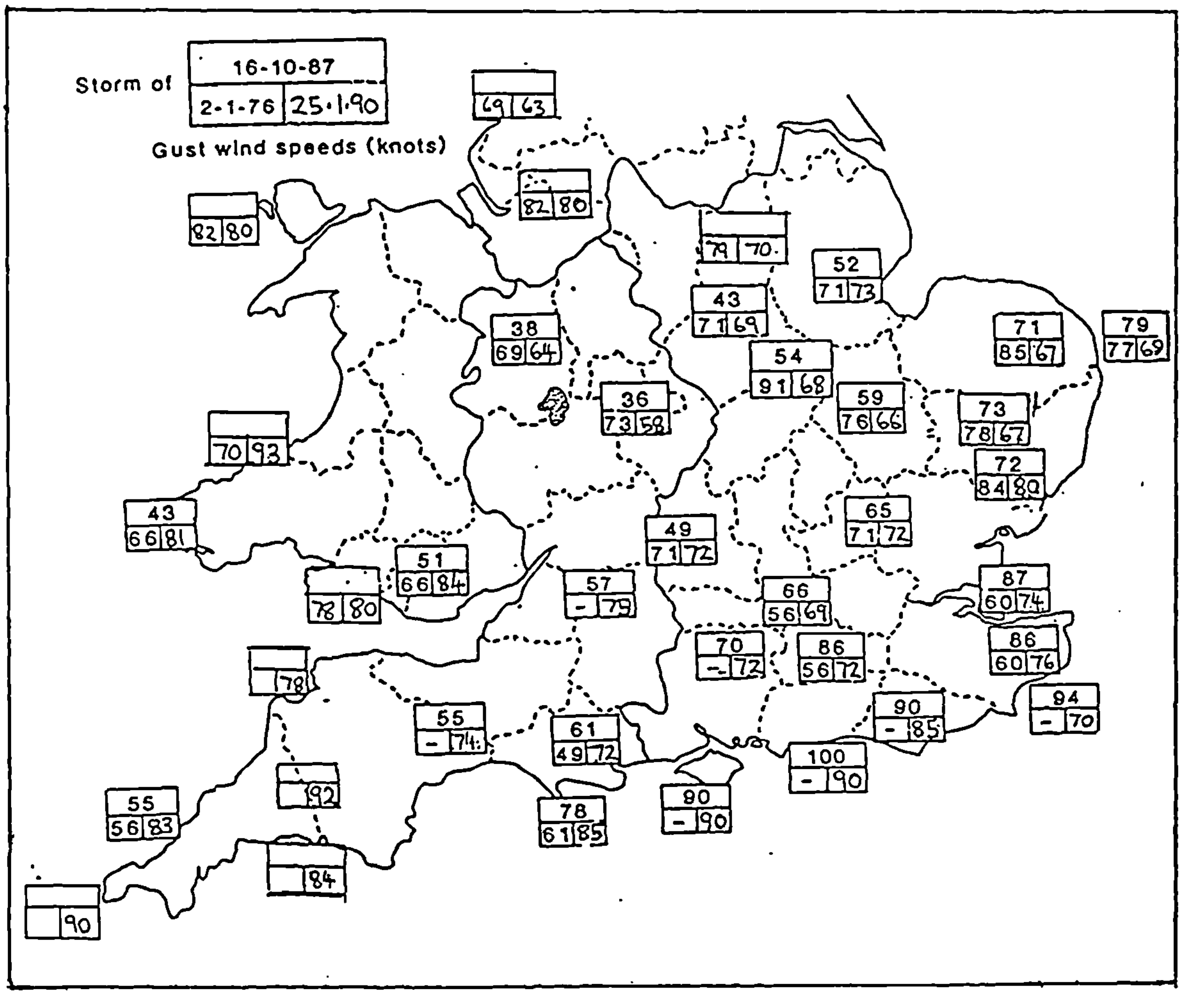


FIGURE 3.3.3.3 The twenty nine stemmed tree - Seckley Beech, Hawkbatch, Wyre

The tree is drawn to scale to the figure in the foreground. It is uncertain whether the Seckley Beech was of a single coppiced stool, or if it was a result of two or three trees fused together and subsequently coppiced. The stems are believed to date back to a last cut in 1880. Whilst the tree survived the gales of 1987 all but two of the stems (both dead) were brought down by a strong gust in 1989. The remaining surviving stems were felled by the Forestry Commission.

CHAPTER 4

THE WYRE FOREST : ITS HISTORY AND MANAGEMENT

Wyre Forest, on account of its large size and turbulent history, fares poorly as a documented site when compared, for example, with Bradfield Woods (Rackham 1976). Its location close to the old industrial heartland of the West Midlands caused Wyre to be subjected, for a prolonged period, to intensive management activity of which clear evidence remains in the form of old saw pits, tracks and hearths. This intense activity was seldom accompanied by a coherent record of the management practices and changes that went on in the forest. Many of the historical references to Wyre refer to ownership and the great deforestation (Camden 1670, Yarranton 1677). This chapter uses all available sources to provide as complete an account as possible of the historical management of Wyre.

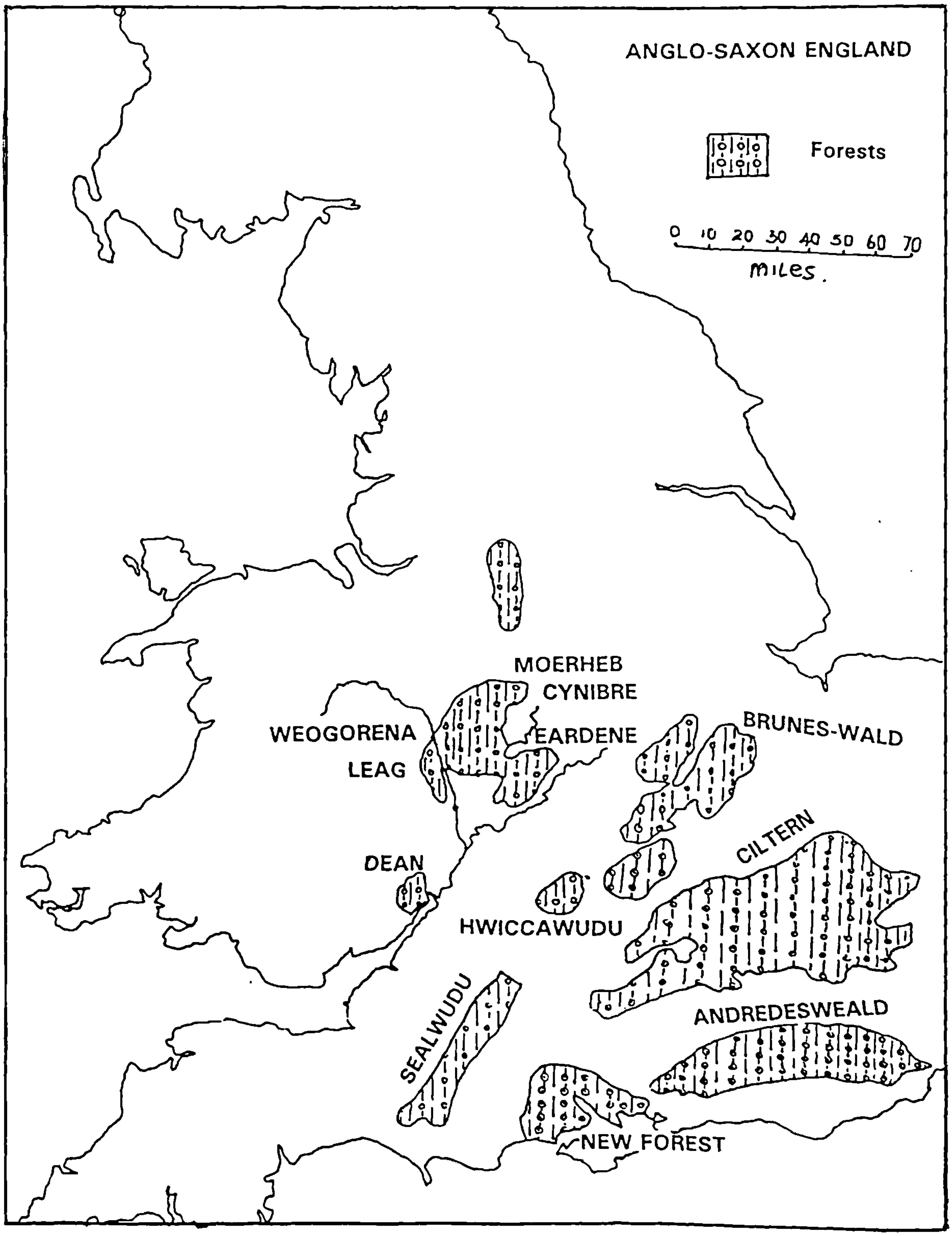
4.1 EXTENT OF THE FOREST

When the Romans invaded Britain, Wyre Forest, then a part of the ancient Coed Mawr, or Great Wood (Wiggins 1986), extended well beyond its present boundaries, incorporating Bridgnorth to the north, Clee Hill to the west, and Worcester south (Worcester is a derivation of "Wyre Castra" a Roman fortified village). Later, during the Saxon agricultural expansion, large tracts of woodland and heath were converted to arable land. However, much of the region around Wyre (referred to by the Saxons as Weogorena) remained wooded as evident from existing Saxon place names which end in "ley" indicating a village or hamlet enclosed by woodland, for example Wolverley, Astley, Highley and Arley. The old forest of Weogorena formed part of a continuous forested landscape which also incorporated "Moerheb Cynibre" with its north-eastern boundaries reaching Lichfield and Tamworth. From these towns the forest stretched south past Dudley to form another Saxon named forest, "Eardene", which had its southern boundaries defined by the

River Avon (FIGURE 4.1.1). The map of Saxon England as portrayed by Stenton (1971) made no suggestion of there being extensive woodland across the Malverns, Clee Hill or north-west of Bridgnorth (sites which saw the establishment of royal forests during the Medieval times), possibly as these areas were still under Welsh influence. For instance, of Malvern Chase, Leland wrote: "The Chase of Malvern is bigger than the Wyre or Feckenham, and occupieth a great part of Malvern Hills. Malvern (as I hear say) is in length in some places twenty miles". Therefore, we cannot accurately assesses the full extent of Wyre during this period in time.

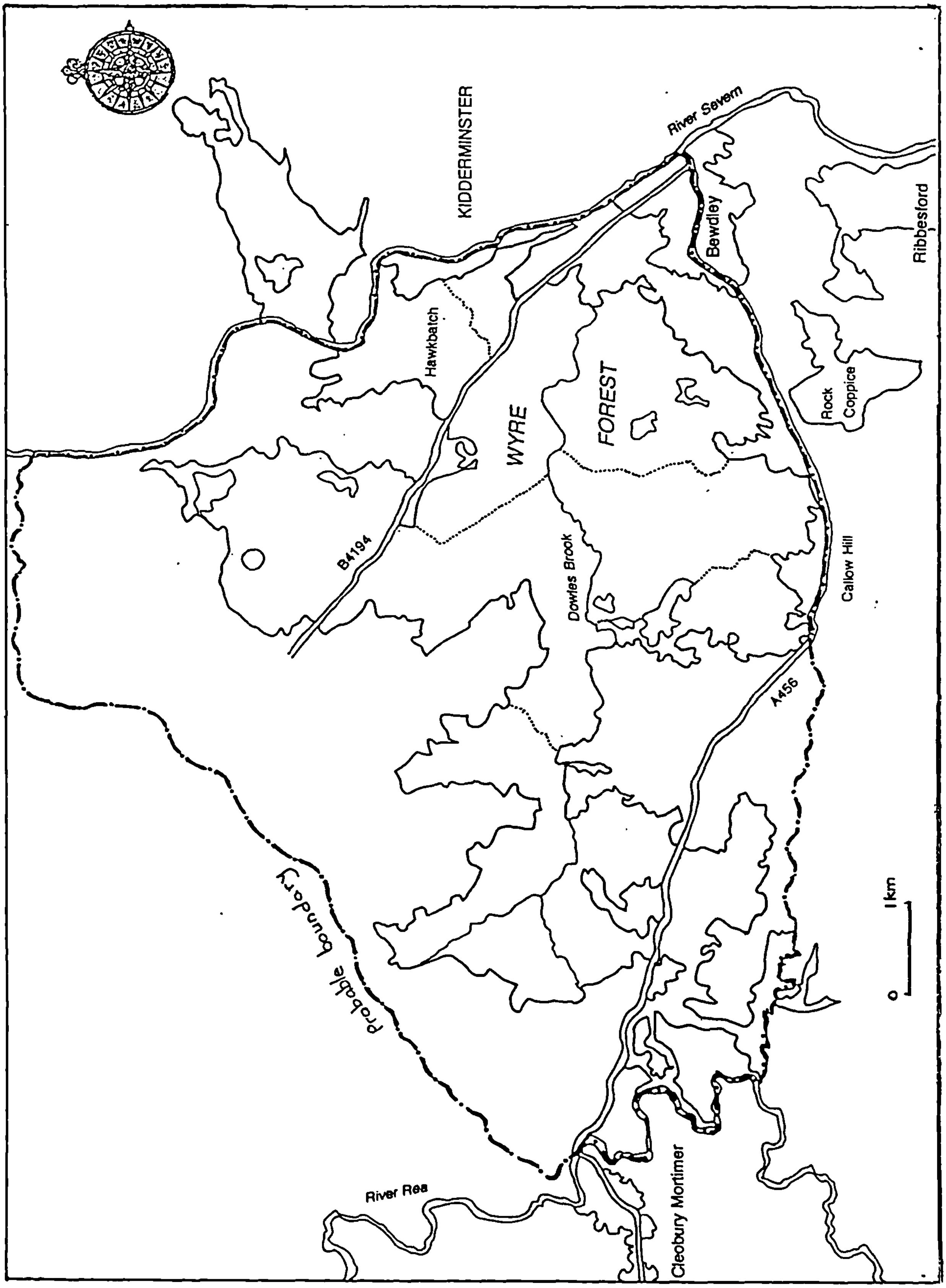
By the time of the Domesday survey of 1086 much of the forest to the east and south of present-day Wyre had been grubbed out, while to the north and west the southern Shropshire forest was slowly being fragmented. Wyre Forest had retreated from Clee Hill, Worcester and Bridgnorth to a much smaller area just west of Bewdley. James (1981) considered that Wyre Forest lay within an area defined as follows. From Cleobury Mortimer, the limits followed the line of the present road to Bridgnorth (B4363) as far as the junction with the road to Highley (B4555), a mile to the north of Kinlet. The limits then continued on this road to its crossing of the Borle Brook which it followed to the Severn. The course of the Severn was followed as far as Bewdley where the limits probably traced the line of the Tenbury Wells Road (A456) as far as Callow Hill and then continued past Buckridge, along the present county boundary as far as the River Rea and so back to Cleobury Mortimer (FIGURE 4.1.2). However, it is uncertain from James's (1981) account as to whether he was referring to the physical or 'political' boundaries of the forest.

FIGURE 4.1.1 Map of Anglo-Saxon England showing the extent of Forest across the country (Stenton 1971)



The former name for Wyre was Weogerena Leag. What the map does not show is the extent of the forest westwards into Shropshire.

FIGURE 4.1.2 Probable extent of Wyre Forest in Medieval Times (after James 1990)



The real extent of the forest, whilst rather more fragmented by this time, was probably larger, possibly incorporating Rock Coppice, Ribbesford and Arley Woods, Menithwood as well as woodlands on the east side of the Severn, including Eymore, Wassell Woods, Rhydd Covert and Shatterford, a view also supported by the brief account of Wyre (Wiggins 1986). Reference to the Domesday Book by Morris (1982) makes mention of woodland, belonging to the Manor of Kidderminster, extending over 4 leagues (that is 4 x 4 leagues, or 6 x 6 miles), as being within the forest. Furthermore, it referred to woodland at Alton (no longer recorded on map but understood to be just west of Bewdley) as being 3 leagues long and 2 leagues wide (4.5 x 3 miles - Morris 1982, this would take into account both Rock Coppice and Ribbesford Woods). An independent account (Millward and Robinson 1971) on the extent of Wyre during the Medieval period also depicted a rather more extensive forest than that described by James (1990). Wyre was described as having its boundaries defined by the royal manors of Cleobury Mortimer (SO6775), Stottesdon (SO6782) and Kinlet (SO7181) to the north, and the manors of Ribbesford (SO7874), Rock (SO7371), Mamble (SO6871) and Bayton (SO6973) to the south. Within the present-day landscape the remaining area of Wyre Forest is still linked to numerous outlying woodlands by a network of ribbon and riparian woodland.

The forest changed little over the next 800 years. Leland, who made his itinerary in the middle of the sixteenth century, commented about Wyre:

"Wire Forest where of summe part is sett in Worcestershire but the moste parte in Shropshire and stretchithe up frontholt upon Serverne onto Bruge Northe. Bewdley is set in the marchis of this forest and stretchithe a 2 miles beyond.. Wire is more than xx mills compas."

John Speed's 17th century map (FIGURE 4.1.3) drew the boundaries at Cleobury Mortimer, Heightington, Kinlet and Bewdley, giving a forest area of 4048 hectares. Earth-works constructed in the sixteenth or seventeenth centuries A.D. encompass much of the

FIGURE 4.1.3 John Speed's map of the Western counties with Wyre Forest clearly marked.

present-day Wyre Forest and are testament to the early destruction of much of this once far larger wildwood. Lea (1922) recorded that further losses over the next two centuries left Wyre with just 6,000 acres (2429 hectares) of woodland, its present size.

4.2 OWNERSHIP OF WYRE FOREST

During Saxon times, Wyre Forest, like many other sizable woodlands, was registered as crown land. Following the Norman invasion the Shropshire side of the forest was granted to a powerful landlord, Ralph de Mortimer, Earl of Marches in the first half of the 12th century and remained in his family until 1461. Soon after Edward de Mortimer, the 7th Earl of March, was crowned Edward IV, this part of Wyre was reinstated as a royal forest. The crown also maintained certain forest rights over the Worcestershire or Bewdley part of the forest as late as the time of Elizabeth I (Lea 1922)). Often, reference is made more specifically to "Bewdley Forest" in historical records. Exactly when Wyre was disforested is not known but perhaps before 1552 (Lea 1922). After a brief period during which the Chase changed hands twice, the Mortimers regained ownership of the land and retained it for almost two centuries (Lea 1922). Finally, the forest moved into a new period of ownership and in the late 18th century was divided between the Kinlet Estate, the Blounts and several rich Birmingham families. Included in the quest to buy up land in the forest were Quaker families from nearby industrial centres as well as local traditional families some of which were the very first private purchasers of the forest in the late 18^{th} and early 19^{th} centuries following from the sales of Mortimer's land. In 1925 the Forestry Commission, then recently established, acquired substantial areas of Wyre and by the 1960s it owned almost half of the forest. The remainder of Wyre was divided amongst various landowners (TABLE 4.2.1) many of whom were business merchants from Birmingham. Corporate organisations including private forestry firms; and the local wildlife trust also purchased woods within the forest.

TABLE 4.2.1 EXAMPLES OF ACQUISITIONS AND DISPOSALS
Schedule of Information from Conveyance, Dispositions, Leases and Feus

Forestry Commission Area: Wyre Forest

DATE	NAME OF OTHER PART	PROPERTY	HOW ACQUIRED OR DISPOSED OF	AREA (ACRES)	
				TOTAL ACQUIR OR DISP. OF	NET TOTAL TO DATE
31.12.25	E.J.Roberts	Alton Park	Conveyance	740.171	
10.8.28	Wm. J.Brockway	Pt.Alton Park	Conveyance	0.836	1618.157
13.6.30	Wm. J.Brockway	Pt.Alton Park	Conveyance	1.000	1617.157
24.6.38	Sir W.Blount	Brand Wood	Conveyance	603.567	2220.724
6.12.51	Public Trustee	Pt.Kinlet Estate	Conveyance	795.875	3192.228
9.11.54	British Transport	Pt. Alton Park	Conveyance	0.325	3191.903
5.4.55	Salop C.Council	Pt.Kinlet Estate	Deed of Ded.	0.080	3191.823
28.5.57	Public Trustee	Pt.Kinlet Estate	Lease	236.592	3574.575
19.7.63	W.Pound	Alton Park	Conveyance	0.5	3820.806
11.8.69	British Railways	Railway Line	Conveyance	12.000	3830.946

One other major landowner in Wyre is English Nature. In the 1950s the then Nature Conservancy Council acquired a small area of ancient semi-natural woodland and declared it a National Nature Reserve. The Conservancy then embarked on an extensive survey and evaluation of the whole forest with the intention of acquiring more land for conservation and finally in 1990 a large tract of woodland, Hitterhill, was bought from Economic Forestry Group. English Nature now owns just over 405 hectares of Wyre forest (although their influence as managers extends well beyond the reserves into areas of the forest declared as SSSIs).

4.3 THE MANAGEMENT OF WYRE BETWEEN DOMESDAY AND THE 16TH CENTURY

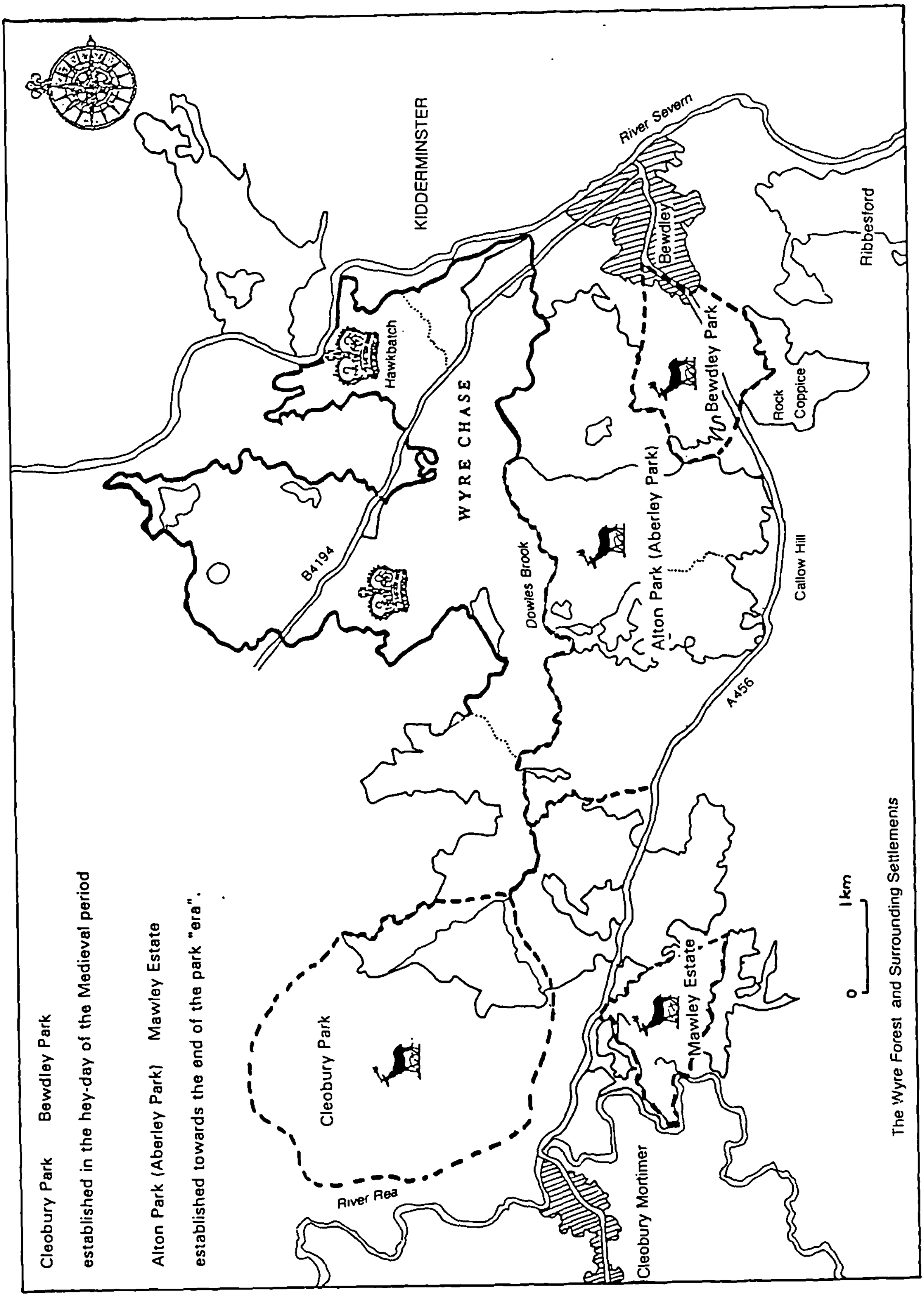
Records of the exploitation of Wyre Forest by man extend back for at least a thousand years. Lea (1922) claimed that Wyre had the status of a Royal Forest during Saxon times, but that apart there was little detailed information on the ownership or management of Wyre prior to the Norman conquest.

In the 12th century, Wyre, at that time a Norman Chase, was managed as a forest in the traditional sense of the word (as defined by Rackham 1986), i.e., as a region in which the King or other magnate had the right to keep deer and to make forest laws. Bewdley Park and Cleobury Park, and much later Earnwood, Kinlet, Alton and Mawley Estate, now part of present day Wyre, were all heavily stocked with Fallow deer (Dama dama). In Bewdley Park there were as many as 16 deer per 10 hectares. These animals were kept apart from the Red and Roe deer which roamed free within the Chase (Lea 1922).

The distinction between Park and Chase, according to Turner (1901 - "Select Pleas of the Forest", p.CXXii), was small. In Turner's definition a park was a distinct enclosed area with a paling, while a Chase was usually not enclosed. The exact borders of Wyre Chase are not known although it is likely that the southern border was originally the Dowles Brook and that the Chase extended north to the Kinlet Estate, east to the River Severn, and west to Cleobury

Mortimer. The earliest Medieval parks to be established within Wyre Forest were Cleobury and Bewdley; both were extensive (FIGURE 4.3.1). Rather later (between the 14th and 16th centuries), a number of other parks and estates were established in and around the forest including Kinlet Estate, Earnwode, Kingswood, Mawley Estate and Alton Park. There is some confusion as to the extent and exact location of these parks; for example, Lea (1922) quoted Nash (1781) as stating that Abberley Park (assumed to be synonymous with Alton) extended into County Worcestershire, from Bewdley to Lem Brook (4 1/4 miles) and from Dowles Brook to Abberley (6 miles). However, there is little evidence to support this statement although the presence of two period properties (Park House, SO738762, and Lodgehill Farm, SO759767, both thought to date from the 16th century) would suggest the existence of a large park within the forest south of the Dowles Brook. Further evidence to support this view exists in the form of other place names scattered throughout the forest south of the Dowles including Brandlodge Coppice (SO737752); Oxbind Coppice (SO743745); and Old Lodge Bind Coppice (the original name for Town Coppice -(SO760760). In these last two examples the term "Bind" depicts fencing or panelling (James 1990), otherwise "addering"- a frequently used system for enclosing parks. An alternative view is that Alton Park (later renamed New Parks) extended from Park Brook west to Lem Brook, and from its northern boundaries along the Dowles it stretched southwards as far as the A456. Old names for features which still exist, such as Lodge Hill Farm and Park House, and natural boundaries provide some support for this view.

FIGURE 4.3.1 The probable boundaries of Wyre Chase and the surrounding parks in Medieval Times



During the Medieval Period Wyre, like all other chases and forests, was subject to special laws, the chief purpose of which was to ensure that the forest was stocked with deer to provide a constant source of fresh meat. Cattle and sheep were seldom fattened for the tables of the rich (James 1981), and the main source of meat lay in the forests where deer roamed in large herds and boar in more restricted areas. Parts of the forest were also managed as a woodland, i.e., underwood was coppiced regularly. There was considerably less harvesting of timber and this was strictly controlled and documented (FIGURE 4.3.2). However, at this time hunting was the most important influence on the management of the forest. As long ago as the 12th century local people were granted rights of common of pasture. About this time pigs were certainly grazed in the forest as is borne out by the old name for "Cold Harbour Coppice" (SO745745), which was "Pigmast Coppice." By the late Middle Ages 'squatter' settlements, such as those at Far Forest and Callow Hill, were established. These early settlements soon became a problem and in 1270 the inhabitants of the surrounding countryside fenced in part of the forest for four miles, to keep the deer in, but Roger de Mortimer leveled two leagues of this fence, so as to restore free transit to the deer. Despite the efforts to enforce forest law, Wyre declined under the impact of the local inhabitants during the latter half of the Middle Ages as borne out in Lea's account of Wyre (1922) in which a local historian, La Bourne, was quoted as evaluating Wyre as "having no yearly value because its use as common pasture has inhibited all regeneration and left no underwood".

Just how the forest was managed for timber and wood during the period Wyre was a Chase is unclear. Whilst coppicing was widespread in Britain during the Medieval Period it is uncertain whether hunting forests were managed in the same way as smaller, private woodlands. Historical literature (Yarranton's account of Wyre - 1677 quoted in Lea 1922), emphasizes the tall majestic oaks

FIGURE 4.3.2 An extract from the Grants of Oak for Wyre Chase,
Dating back to the 12th century (taken from Lea 1922)

(The keeping of such a register demonstrates the level of efficiency and attention given to the management of timber during the Medieval Times.)

GRANTS OF OAK.

The following grants of oaks or building material occur when the Chase was in the King's hands :—

1177. (10) In rendering an account of the farm of Worcestershire, Michael Belet, the Under-Sheriff, states that he has spent 60/- by the King's writ for the carriage and escort of building material (maisremi) "de foresta de Wira" to Godestowa. Perhaps Henry II. gave this present to the Nunnery of Godstow, near Oxford, because Fair Rosamond had been educated and afterwards buried there in 1177. She was the daughter of Sir Walter de Clifford (10a), a collateral descendant of Drogo Fitz-Pontz, who held the manor of Stilden (Rock) in Domesday Survey.

1239. (11) Gift of one oak in "Werewud" to the Master of the Knight Templars.

1246. (12) Consent to Ralph de Clare, Earl of Gloucester, and the Abbot of Tewkesbury to remove from "bosco de Wyre" certain building material (maeremium, buscam et scindulam) purchased from Ralph de Mortimer deceased.

1246. (13) Gift of 20 oaks for building material in "foresta de Wyre" to John de Plessy, Earl of Warwick, who held the manor of Stottesdon.

1323. (14) At an Inquiry held at Cleobury by the Escheator it was alleged that carpenters who had come in the Chase of Wyre on the King's part for the Castle of Hanley (perhaps for Edward II.'s favourite Hugh Despenser, of Wyre, together with a woodland structure much more conducive to the hunting of stag and hind than coppice thicket. From this it is possible to surmise that Wyre was rather primaeval in nature with very large, maiden trees and a well-developed understory where grazing permitted (Lea 1922). Small-scale random coppicing of underwood would have served the Common Rights of Cord. It is very possible that in the absence of intensive coppicing there was a greater proportion of trees and shrubs arising from seed rather than coppice stools. If this was the case then the greatest change in Wyre occurred during a period of rapid transition following the demise of the Chase.

The last half of the 16th century witnessed a turning point in the history and management of Wyre. As Royal Forests across the country fell into decline (Rackham 1986), interest in Wyre as a hunting ground was quickly superseded by the demands for timber and wood. The deer within the Chase were a welcome source of meat for the squatters and were also viewed as a pest by those whose interests lay in timber. Consequently they were rapidly poached out of the forest (Lea 1922). The bulk of timber trees together with the coppice was cut down and processed into charcoal for the fuelling of forges and the salt evaporation industries. Around the second half of the 16th century and first half of the 17th century there were an estimated 20 000 smiths within 10 miles of Dudley Castle (Dudley 1665) and of the wood fed to these forges large quantities came from Wyre (Lea 1922). Young coppice poles were used to fire the salt furnaces at Droitwich. Over a year some 6000 loads were extracted from Feckenham and Wyre (Penistan 1963). It is uncertain what constituted a load in those days. However, if a reasonable assumption was made that there were approximately two "cords" to a load (1024 ft^3), then an estimated 30,000 tons were exported to Droitwich. A commission set up in 1592 to investigate the "spoyle of Wyre Forest" identified the cause of deforestation as the illegal sale of timber by the crown's agents in the area. The devastation of Wyre drew concern from many historians. Haberton, who died in 1647, referred to the utter overthrow for fuel of the

late renowned forest of once flourishing Wyre. Camden (1670) wrote of this district:
"Bewdley... justly denominated from its beautiful situation, most pleasantly overhangs the river to the west on the side of a hill, having near it Wyre Forest, remarkable lately for the tallness of its trees, which are now almost gone. Whence our antiquarian poet Leland: Fair seated Bewdley, most delightful town, Whome Wyre's tall oaks with lofty leafage crown."

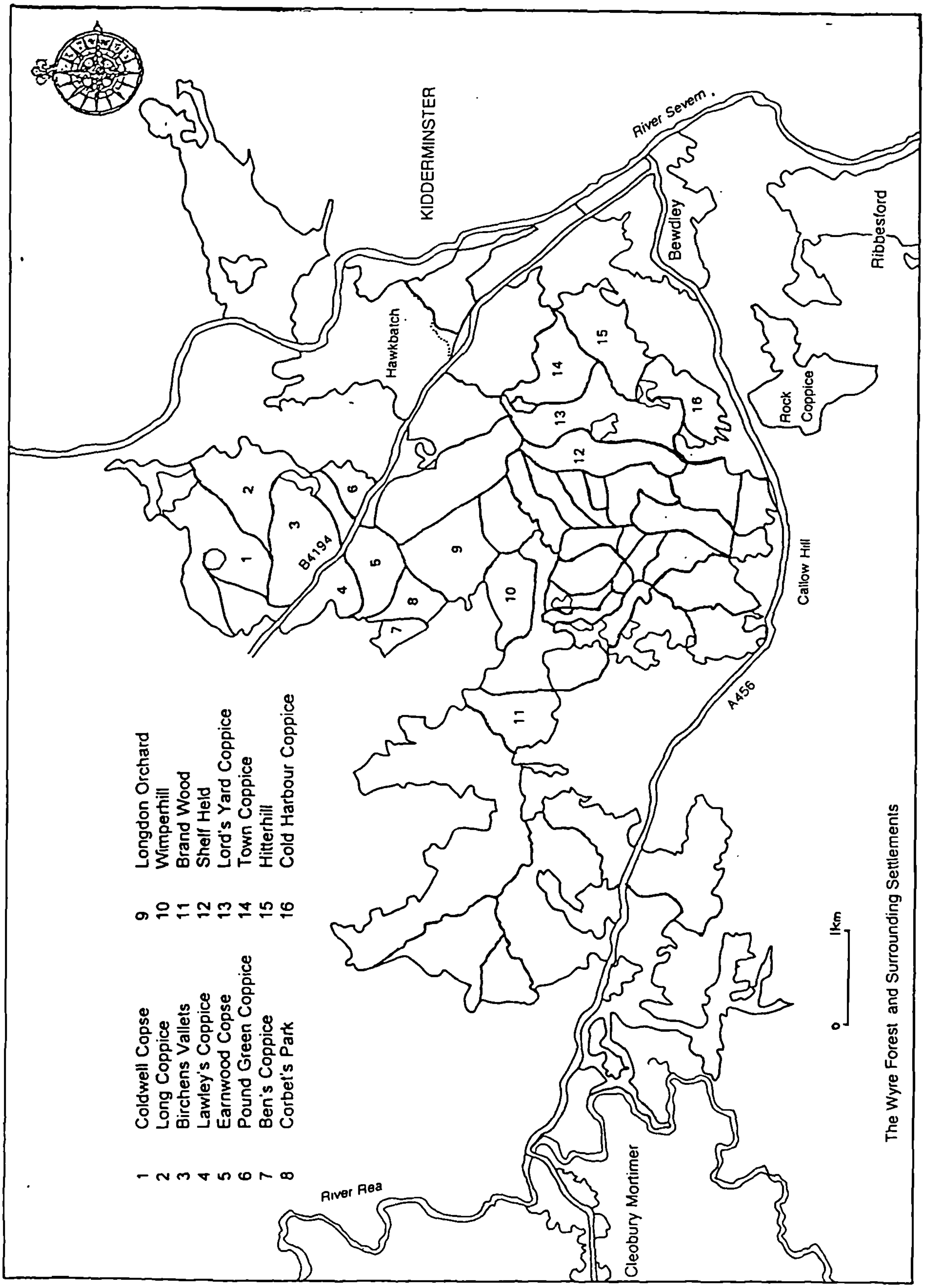
Drayton lamented the cutting down of the trees for charcoal:

When soon the goodly Wyre, that wonted was so high
Her stately top to rear, ashamed to behold
Her straight and goodly woods unto the furnace sold
(And looking on herself, by her decay doth see
The misery wherein her sister forests bee).

Finally, Yarranton (1677) referred to the complete deforestation of Wyre during the reigns of Elizabeth I and James the 1st. He was quoted by Lea (1922) as stating that, in 10 000 acres of forest, barely 100 good trees (taken to mean worthy standard), could be found whilst at one time Wyre supported approximately 40-50 oak standards per acre (Penistan 1963). If this information is taken in the context of Lea's statement on the deforestation of Wyre as having occurred between 1550 and 1650, it can be supposed that an estimated 4000 good oak (approximately 8000-10 000 tons) were felled each year during this 100 year period. Only when stiffer legislation was introduced, later in the seventeenth century, to control the removal of timber from forests (including the 1663 Act for the punishment of unlawful cutting or stealing or spoiling of wood and underwood and destroyers of young timber trees) did Wyre show any signs of recovery.

At about this time Wyre was divided up into coupes or coppices (FIGURE 4.3.3), identifying various ownerships of woodland. Each area was delineated by an earth mound, often incorporating yew and holly trees. In some cases these boundaries were hedged with hazel

FIGURE 4.3.3 Woodbanks and coupe boundaries in Wyre Forest



and hawthorn (relic hazel hedge can still be seen in the northern portion of New Parks, Forest Enterprise).

Management was better following the great deforestation. After every cut, coppices were enclosed for 7 years and then thrown open as being common (Prattinson MSS 1650). The form of management practiced until the 19th century was along the lines of traditional coppice-with-standards. Coppices within coupes were cut on a rotation of 17 or 18 years to produce the most suitable sized poles for the production of iron bars (James 1990). This vital economic market for wood had its impact on the forest as expansive homogeneous stands of coppice oak were relentlessly encouraged at the cost of other species of tree. Laird, 1818, quoted in Lea (1922), marveled at the dense stands of oak poles and underwood which he described as being more akin to a nursery than a forest. The increasing use of coal as the industrial revolution proceeded created new market forces which were again to exert an influence on the forest.

4.4 MANAGEMENT OF THE FOREST FROM 18TH CENTURY TO PRESENT DAY

4.4.1 Traditional woodland management

Towards the end of the 19th century most of the forest was divided amongst various land owners. A group of Quakers belonging to the Progressive Birmingham Quaker Group established small holdings within the forest and, on its boundaries, planting orchards to supply Birmingham with fruit (Guild of St George c.1930). The Quakers have left a legacy of numerous orchards scattered around the edges of the forest and along the Dowles Brook.

It is believed that much of the present coppice was first worked as such about 170 years ago (Guild of St George, c. 1930), "following a period of disruption" which may have some connection with another major event which brought about deforestation, namely, the Napoleonic Wars (1793 - 1815), (Guild of St George c. 1930).

Coppice coupes were still worked on a 17 or 18 year rotation although the system was more akin to selective coppicing in that only a portion of the coppice growth was removed during each cycle. Coppice blocks, which ranged from approximately 22 acres (Ben's Coppice, 736777) to almost 200 acres (Lord's Yard Coppice, 757753) were divided into smaller falls ready for cutting (George 1987). If an estate, such as Kinlet, owned substantially more than one coppice or wood within a larger woodland the separate areas were managed as a lot, i.e., falls within the various coupes were managed on rotation. Rarely were two falls within the same or adjacent coupes felled in the same year (FIGURE 4.4.1.1). Under this system of management standards were grouped roughly 30 to the hectare while coppice stools were at a much higher density, in places 1000 - 1500 to the hectare.

More recent accounts (Guild of St George c.1930, and George 1987) of forest management at the beginning of the twentieth century illustrated the considerable diversity which existed in the timber market, and the impact this had on silvicultural practices. However, it would appear that there are no official records of timber extraction or stocking densities suggesting that all workings in the forest up to the turn of the century was based on local understanding of traditional management passed on down from generation to generation.

At the start of a felling programme each tree suitable for sale was marked, including the smaller wood. Small stems were marked with a band and large ones with a ring of dots. Mature standards, 120-150 years old, were stocked at roughly 25-30 trees to the hectare (George 1987) and amongst these large trees were a certain number

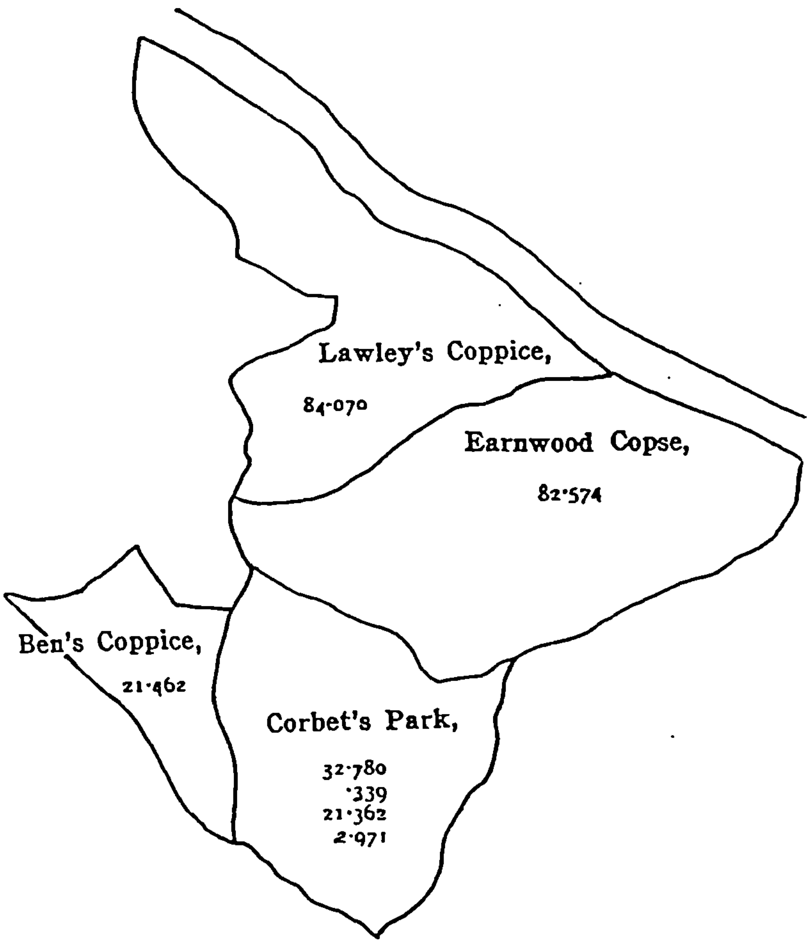
FIGURE 4.4.1.1 Four of the coupes owned and managed by Kinlet Estate

The records illustrate the style of coppice management carried out in Wyre Forest throughout the 19th century and towards the beginning of the 20th century.

Total area, 245a.

SCHEDULE.

DESCRIPTION.	AREA. ACRES.	LAST FELLED.	NEXT FALL DUE.
Parish of Kinlet.			
LAWLEY'S COPPICE.			
Oak Underwood	84·070	About 59 Acres. 1903/4	1922
		About 56½ Acres. 1904/5	1923
EARNWOOD COPSE.		About 51 Acres. 1905/6	1924
Oak Underwood	82·574		
CORBET'S PARK.			
Oak Underwood	32·789	1902/3	1921
Oak Underwood	·339		
Oak Underwood	21·362	1903/4	1922
Line of Pipe Track	2·971		
BEN'S COPPICE.			
Oak Underwood	21·462	1911/12	1930
	A. 245·558		



of smaller, singled stems of 18, 25, 50 and 75 years old. In total there were between 90 to 150 sizeable stems (8+ cm diameter) to the hectare together with a dense understory of coppice wood ranging in age from 1-18 years old (George 1987). The stool stocking density varied between c.700 - 1000 to the hectare (Hobson 1995a). Once the stems within a fall had been marked, the small-wood merchants (barkers, basket makers, charcoal burners) would buy the wood for cutting on standing sales purchase. Much of this small wood (bean sticks, rustic or "hooping" poles - 8 year old, and refinery poles - 13/15 years old) would be felled whilst leaving a few good poles to grow on. In autumn timber merchants would work the forest cutting pit props (18-25 years old), and a very small number of timber trees (70-150 years old) (Guild of St George c.1930). In his account, Edwin George gave a slightly different picture of the age of the various stands (FIGURE 4.4.1.2). All "oil sticks" (5-8 years old) were cut out together with rather older bean sticks (8+ years old). However, 1-3 good bean sticks per stool were kept on to provide lagging poles (25 years old). Again a selected few lagging poles were retained to provide pit props (50 years old). Fewer still of these were allowed to grow on to produce timber sticks (70 years old). Finally, post timber sticks were selected from these to form the standards (125-150 years old). An estimated 20 - 25 standards, 37 pit props and 37 lagging poles occurred at any one time on each hectare of the forest (Hobson 1995a); that is approximately 90 - 100 sizeable poles to the hectare (FIGURES 4.4.1.3a & 4.4.1.3b). Any acorn sapling was left to grow on to form a timber tree so, throughout the forest, many of the fine (30+ cm diameter) standards were maiden trees.

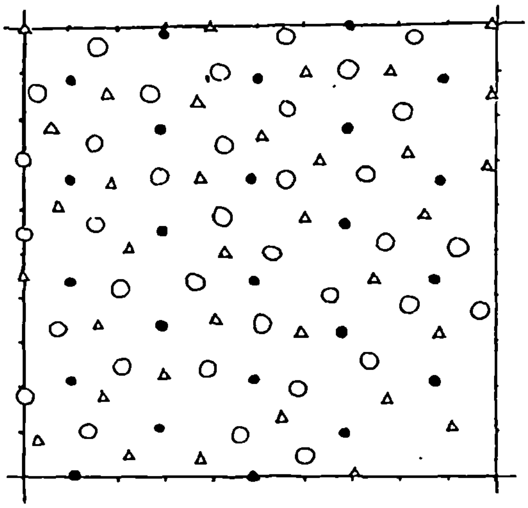
FIGURE 4.4.1.2 The range of wood and timber products extracted from the forest under the selective coppice-with-standards regime.

(Guild of St. George c.1930)	(George 1987)
----------------	Oil sticks - 8 years old
Bean sticks, hooping poles - 8 years old	Bean sticks - 8+ years old
Refinery poles - 13-15 years old	Lagging poles - 25 years old, (15 trees per acre)
Pit props - 18-25 years old	Pit props - 50years old (15 trees per acre)
----------------	Timber sticks - 70 years old
Timber trees - 70 - 150 years old	Standards - 125 - 150 years old (8 - 10 trees per acre)

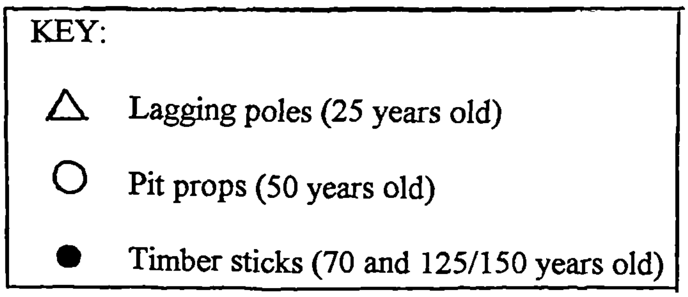
The two sources of information differ slightly although more weighting is given to George's (1987) account as his family worked in the forest for many years.

FIGURE 4.4.1.3 Selective coppice-with-standards system of management in Wyre Forest

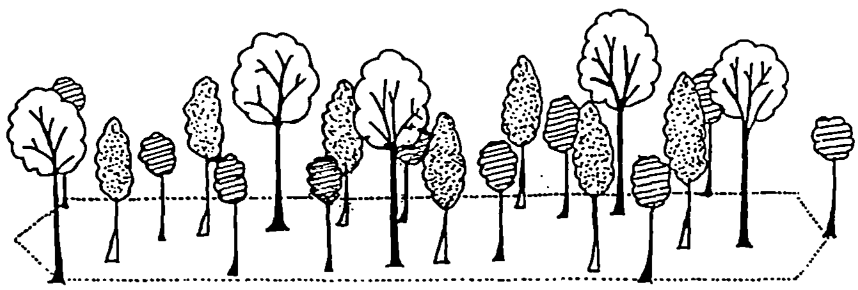
a)



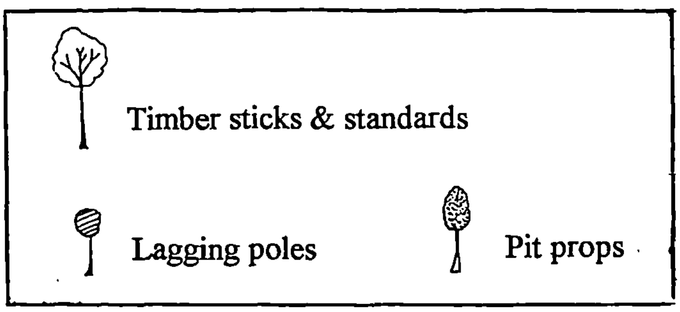
A representation of a 'cleared' coupe as it would have appeared under the traditional form of management. A selection of different aged trees remained within a fall after woodmen and timber merchants had worked their way through a coupe.



b)



Diagrammatic representation of a transect 140m long and 15m wide taken diagonally across a 1 hectare plot to illustrate the possible structure of a worked coupe.



Small coppice wood produce was marketed as bean sticks, whilst smaller diameter wood was sold to nearby factories for use as oil sticks (small poles had their tips wrapped in wadding and then dipped in grease or oil to use in the process of oiling working machinery parts). The 'hooping' (5 cm - 10 cm butt) was used for rustic and all types of fencing. There was little hurdle-making in this area although there was much use for plaited fencing (addering) in fixed positions. Large quantities of light stems were also used in the pottery area of Staffordshire and Birmingham for making crates to transport pottery. Oak baskets or "whiskets" were also made from small wood and supplied a steady demand for use in collieries, and on potato farms in Scotland.

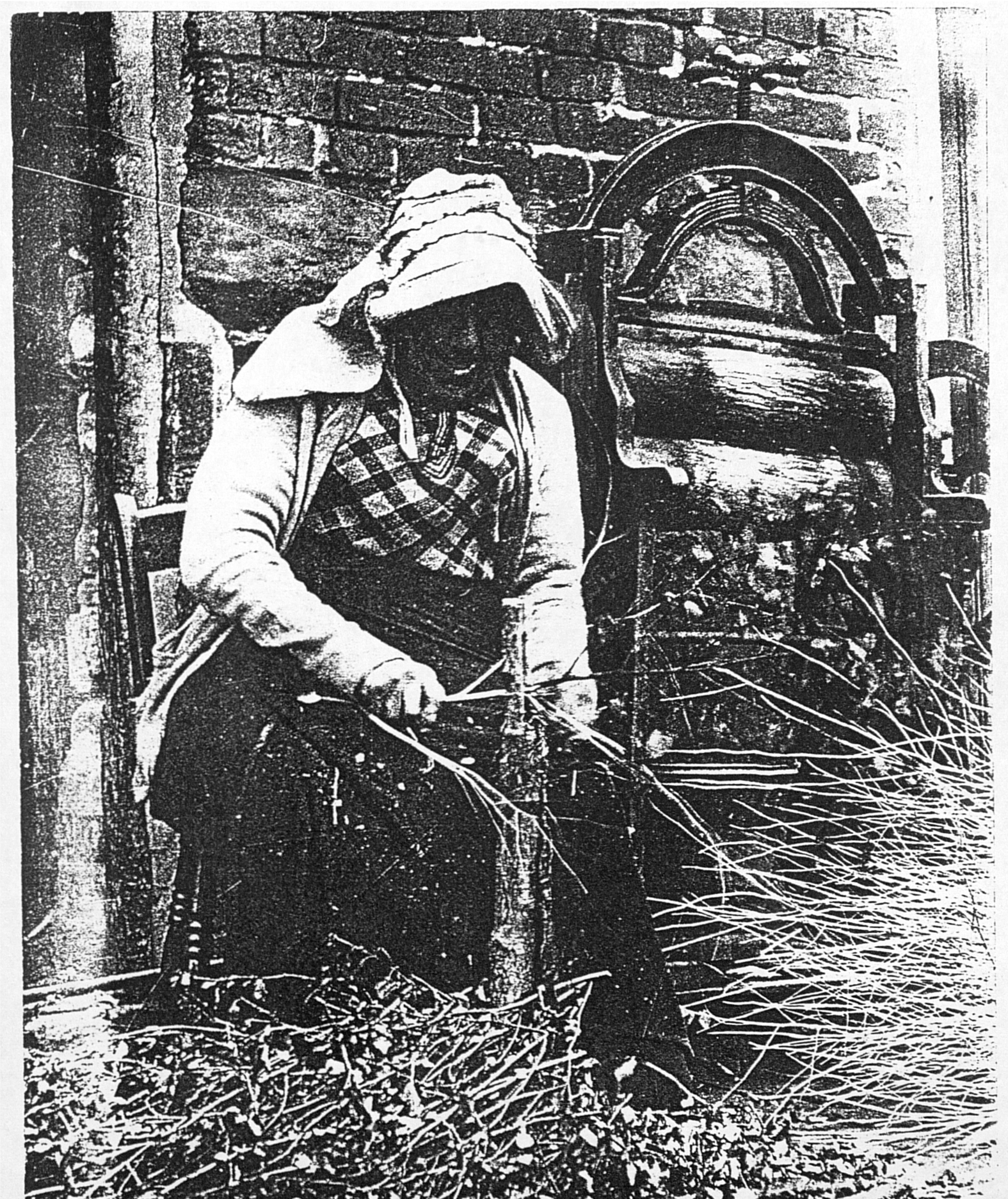
The bigger poles, next size up, went for burning in the refineries and fetched a penny a piece, giving rise to the name "penny-poles". These sticks were of just the right size to feed into the holes at the top of the furnace and the other name for these sticks was refinery poles. Pit-props were prepared in the timber yards and sold for use in the South Staffordshire Coalfield. The processing of the timber from the forest took place off site in the timber yards dotted around the edges of the Wyre; very little of the conversion occurred within the forest. Hauliers, waggoners or horse drivers operated in the forest until WW2. Shire horses or shire crosses, mainly owned by the timber merchants, were mostly used, two to six horses at a time depending on how big the task was, although on a number of occasions 14 horses were used in one trace (George 1987), (this may account for some of the deep tracks which criss-cross the forest). Chain horses would be used to drag timber to track side where these logs would be loaded up onto the waggons for transport to the timber mills. By the 1930s hauliers were using a combination of trucks, tractors and horses to extract timber.

Birch also provided a valuable marketable wood although it was rarely allowed to reach maturity. It was cut back in the early stages of growth, possibly at the same time as bean sticks were removed. The birch brash was used for constructing besoms and whisks. To produce a 'good' whisk the birch bark would have to be stripped off the twigs by drawing it through a narrow fork made out of oak (PLATE 4.4.1). Heather and yew twigs were also used. Ready-made whisks would be sold to the carpet industry to be used to remove the 'bobbles' from the new carpets.

Besom handles were made from hazel cut from the valley woodlands. Before the manufacture of twine, the birch brash was attached to the handle with bramble which had been stripped of thorns using a hand-held wooden comb. Use was also made of bracken which was cut as packing for the fruit picked from the Wyre Forest orchards and destined for the Birmingham markets. Large boxes of fruit similarly protected in bracken fronds were dispatched from Birmingham to Scotland.

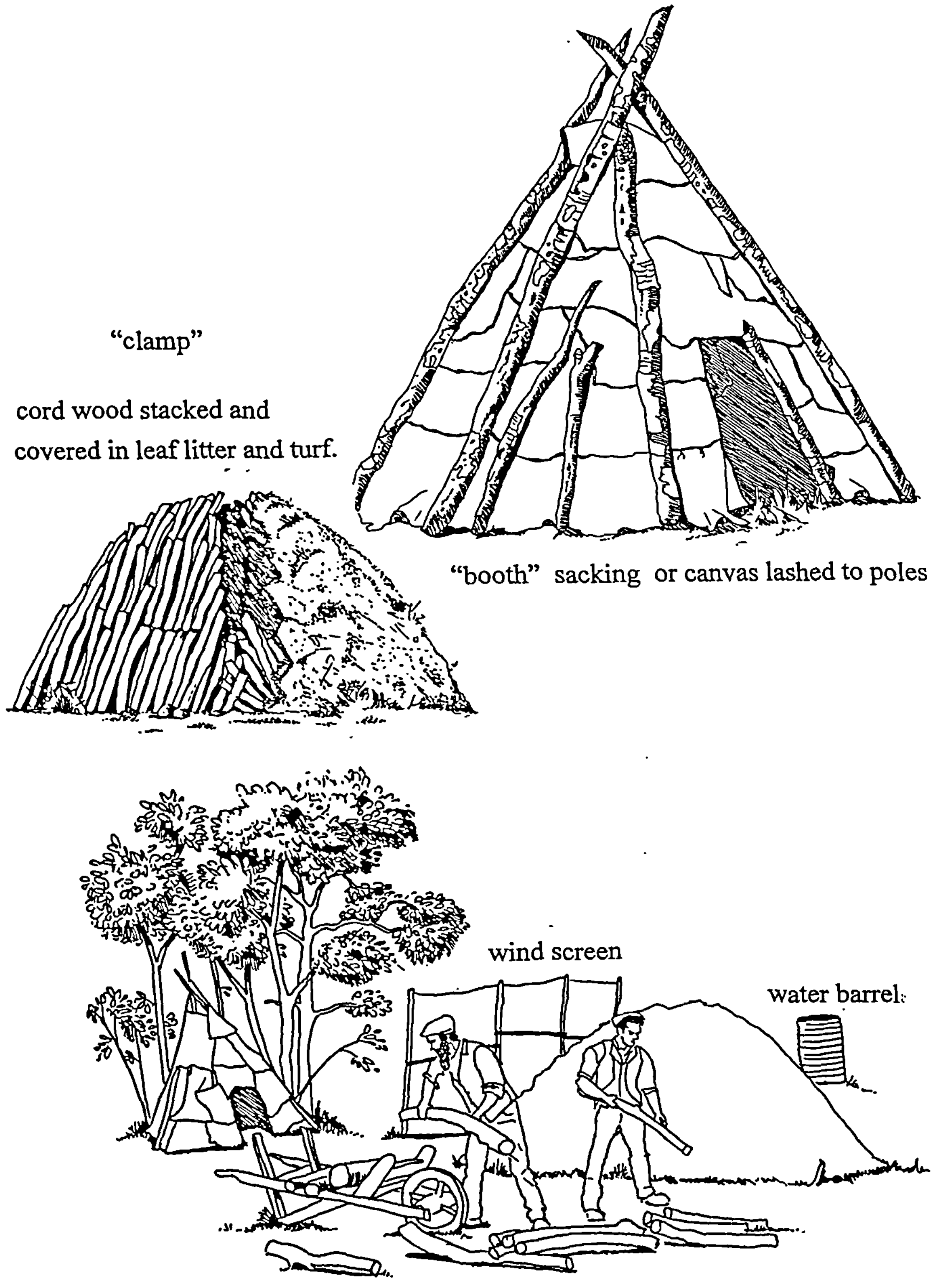
Bark peeling for the tanneries was a principal industry in this region. When the sap was up teams of women and boys worked on peeling coppice poles and timber sticks stacked by trackside. The bark was stacked up on poles to dry. When dry it was bundled and loaded onto waggons for transport to the tanneries in Bewdley. Until very recently all that remained of this industry in Wyre was a single merchant, Albert Link who exported his bark south to a tannery in Cornwall. Every April/May he stripped the bark from timber sticks using a small sharpened spade and stacked it on end around trees to dry. It could remain in the wood for two or three weeks before being bundled and transported back to Albert's yard to dry in racks for a further 1-2 months. The last time this trade occurred was in 1994; this trade may have finally ended.

PLATE 4.1 Stripping birch branches of their bark and leaves to make "whisks", Wyre Forest



After a coupe had been worked the local inhabitants living on the edges of the forest would scavenge the forest floor for brash which provided a valuable source of faggots for firewood. This activity left the forest clean and free of woody litter. Wood used for charcoal was more of a by-product of timber felling. After timber was hauled off site there remained a quantity of small wood which was uneconomic to cart away from the ground. Such wood was customarily sold to charcoal burners. At the turn of the century a charcoal burner normally employed one or two men to assist him; the wages earned were from 45/- to 55/- weekly (Guild of St George 1930). The charcoal burner bought waste wood over large areas of the forest and moved from area to area, spending several weeks cleaning and burning in each site. No more than ten burners were employed at any one time in the Wyre Forest. Most of the men worked in pairs and usually burnt two clamps at a site. Whilst the first clamp was burning the second one would be constructed. Usually 4-6 tons of wood were burnt in each case (Hobson 1995b). Old traditional sites situated close to or on the edge of a stream were used over and over again. Where the hearth was situated away from a main water supply dew ponds were dug on clay ground and these then allowed to fill with rain water. The wood, cut into cords usually three to four feet long, was brought to the site on large wheelbarrows and carefully stacked around a central pyramid (Hobson 1995b) (FIGURE 4.4.1.4). The clamp was then covered in leaf litter, grass and bracken and finally in a thin layer of soil often taken from the last burn. The clamp, once lit, would burn for 4-5 days. When the time came to open it this was done by damping down the stack with repeated buckets of water taken from a large oak barrel, stream or dug-out dew pond. Finally the charcoal was riddled using large oak framed sieves and packed in large hessian sacks to be loaded onto a horse cart for sale in Bewdley and other local centres. Between the two World Wars the more efficient retort system replaced the old pit mound hearth, and the wood was transported either by horse and cart or tractor and trailer.

FIGURE 4.4.1.4 Charcoal burners stacking cord wood at a hearth site.



At the turn of the century Wyre did not provide permanent employment for the inhabitants of the forest. It did, however, provide a valuable subsidiary income for local small-holders. Furthermore, there was a great deal of mutual employment among the people engaged in forest work. Timber merchants would employ hauliers to extract the timber from the forest, or a basket-maker would buy a "fall" and then sell all unwanted wood to a timber merchant. However, fruit growing, not work in the forest, was the mainstay of the small-holders in the Wyre Forest area before the First World War. The timber merchants recruited their own labour from the forest area (Guild of St George c.1930). Women from small-holdings were employed in "barking" although this work lasted only for 6-8 weeks (April and May). Much of the forest work was over the winter period and a good woodcutter could earn £2.15.0 to £3.0.0 weekly at the turn of the century. Gangs regularly at work throughout Wyre usually totaled 70 to 80 men.

Despite the continuation of the local forest industry up to WW2 small-wood markets were in serious decline towards the end of the 19th century. Much of the oak in Wyre was being allowed to develop into high forest with the intention of creating profitable timber. Singling of coppice stems had started around 1860. The First World War and the post-war period brought about rapid changes in ownership of Wyre Forest. Financial pressures encouraged land owners to sell whatever standing timber they had. Consequently, all large timber was removed from Wimperhill (SO 7376), Brand Wood (SO 7276), Longdon Orchard (SO 7477) and Earnwood (SO 7478), reducing these areas to coppice scrub.

The singling of oak marked the end of the extraordinary era of intensive oak coppice management in Wyre which had spanned 300 years, and signaled a return to high forest and the advent of commercial forestry as we know it today.

4.4.2 Modern Commercial forestry

The planting programme

In 1925 the Forestry Commissioners bought about 2000 acres of Wyre and the process of clearing oak and replanting with commercial species began at once. The policy was to clear broadleaved species away completely, both high forest and coppice, and to replace these with conifers. A report published by the Commission on 30th September 1926 stated that 116 acres of land had been replanted; by September 1927 the replanted area had increased to about 800 acres (324 ha). The trees planted were chiefly larch, Douglas fir, and Corsican pine. During the early establishment stage of forestry management in the 1920s and 1930s two major strategies were employed in establishing a crop. In the case of softwoods, the original stand of oak coppice was cut down and young conifer seedlings planted between the stumps. Any subsequent scrub regeneration was periodically cut back. In many cases heather pulling and cutting (involving use of an otter scythe) preceded planting. In other cases bramble was cleared out and wetland flushes drained. In some parts of the forest extensive areas of yew were cut down to minimise problems of shading. In areas where beech was introduced the oak was thinned and underplanted with beech saplings. The planting programme increased steadily, apart from the war years, until the 1960s by which time more than half of the Commission's holdings were under softwood.

When the Commission inherited land bearing a fairly dense, tall stand of oak coppice, it went about its forestry development programme in four distinct phases.

1. 1926-36, oak coppice was clear felled and the ground carefully planted up with commercial trees.
2. 1936-50, oak stools were singled and thinned, and the area underplanted with beech.
3. 1950-57, a variety of treatments was applied to the oak. At the same time 419 acres of dense oak coppice at

Wimperhill were thinned lightly and 'rehabilitated' to very poor high forest.

4. 1958, a treatment plan was drawn up and approved. This programme formed the basis of treatment and progress for the next ten years. The prime objective of the plan was to replace, in a relatively short time, all the low yielding oak and larch with more highly yielding Douglas fir, Norway spruce, pine and beech. A brief summary of an extract from the 1963 Working Plan for Wyre illustrates the proposals for the areas of land still under oak.

a) High oak, 212.5 acres.
Windbelts - thinned; stored oak stands - group felled and enriched with beech and Douglas fir.

b) High oak over beech, 323.5 acres.
Remove all poor oak, retain good oak and encourage beech growth. Poor beech to be replaced with Douglas fir and Corsican pine.

c) Stored oak coppice, 419 acres.
(Brand Wood, Wimperhill, Longdon Orchard). Thin and then enrich areas over next 13 years with Douglas fir, Norway spruce and Corsican pine.

A considerable quantity of oak was cut down during World War Two, when the Ministry of Supply surveyed the woodlands and large scale thinnings of oak were undertaken. All woodland north of Dowles Brook was substantially thinned, together with oak stands on Forestry Commission land, although state-owned woodlands suffered only limited felling. A saw mill on the edge of the forest on the Button Oak road processed the timber.
By the end of the 1950s the area of forest owned by the state had taken on much of its present character (TABLE 4.4.2.1).

Table 4.4.2.1 Extent of afforestation in state-owned Wyre by 1960, (after Penistan, 1963).

TYPE		AREA ACRES	VOLUME (Hoppus feet)	CURRENT ANNUAL INCREM. (Hoppus ft.)
HIGH FOREST:	CONIFER	1,755	1,088,900	98,720
	Mixed	124	13,300	1,480
	Broadleaved	1,101	733,100	18,450
TOTAL HIGH FOREST		2,980	1,835,300	118,650
COPPICE-W-STANDARDS		-	-	-
COPPICE		-	-	-
PARTIALLY FELLED		15	3,100	310
RESERVED TIMBER		50		
SCRUB		370		
FELLED		19		
OTHER PLANTABLE		59		
OTHER LAND		96		
TOTAL		3,589	1,838,400	118,960

(1 hoppus foot = 1.273 ft3; 1 h ft/ac = 0.089 m3/ha)

Following the production of the 1963 Wyre Forest Work Plan much of the larch was felled and a range of conifer species better suited to the variable geology introduced into smaller plantations. Plantation boundaries were redefined, obscuring the ancient coppice earth mounds, and new tracks were cut through the forest.

The forest was divided into six blocks, to be worked in rotation. Each year two blocks were worked simultaneously by coppicing half the area in each case. The construction of forest roads began in

1947 and the first of these were given a layer of coarse grit from the Stourhead Gravel and Sand Company. Later, ash from the Power Station at Stourport was used. The more recent roads were constructed from rubble from reconstruction schemes in Kidderminster, and limestone from Clee Hill. By the late 1980s tighter controls on the planting and draining of wetlands were being enforced and landscape planting regimes were being implemented. Also around this time conservation management plans were drawn up to safeguard key ecological sites.

The most important change in Wyre in recent years (late 1980s) was the reintroduction by Nature Conservancy Council of coppicing into the broadleaf reserves. These coppice areas were divided into one hectare plots and the trees coppiced leaving just 20-40 standards (mixed oak-birch) per hectare.

Staff and labour

When the Working Plan was written in 1963 Wyre Forest was still under the direct management of the Forest of Dean Office. However, three Foresters were based at Wyre to run operations. The labour force was 19 men and a young woman, most of whom had previous connection with work in the woods. Earnings for a Forest Worker averaged 172 shillings a week. The conditions of work had changed little since the turn of the century and many of the employees did contract work in their own time, including cherry picking, gardening as well as small wood working. There was still a good demand for small hardwood produce including turnery, besoms and spray for metal work, garden fencing, rustic, bean sticks and faggots for hop-pickers. These forest workers were able to buy small falls of scrub oak, ready for clearing, for 30 - 45 shillings per acre.

By the 1980s significant changes had taken place. The management of Wyre fell to the responsibility of Marches Forest District Office, based in Ludlow. By 1989 the number of forest workers had been reduced to just two with one Forester to supervise operations. The main burden of the planting and harvesting was now contracted out to private firms.

4.4.3 Recreation

After the publication by the Forestry Commission of the 1967 policy on improved recreational access and facilities, action was taken in Wyre to increase the number of nature trails through the forest substantially and to provide picnic sites at convenient points within the forest. In 1974 a major development at Callow Hill Forest Office (SO 749739) was the construction of a large car park and the opening of a visitor centre. This was followed in 1986 by the appointment of a Conservation Ranger with part responsibility of establishing a school classroom and developing the environmental education interest in Wyre. Other developments included the improvement of car park facilities, relandscaping of the site around the visitor centre, limestoning of many of the forest walks to provide a harder surface, and extensive signposting along tracks and bridle paths. By 1989 new trails had been established and the forest zoned into "open and restricted" recreational areas. In 1993 and 1994 the centre was further extended to include extra facilities for the public, and an additional classroom created.

4.5 ENVIRONMENTAL INTERPRETATION OF MANAGEMENT IN WYRE

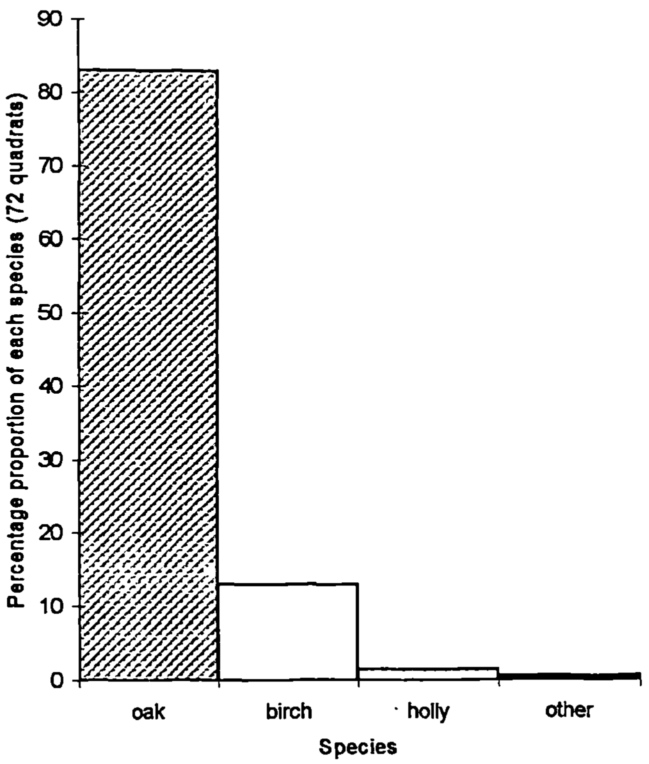
The findings presented in this section are drawn from extensive field-based research carried out in this study. The approach to woodland archaeology adopted here attempts to demonstrate that by recording and analysing a number of variables including species composition, tree and shrub densities and measurements of stem and pole diameters at breast height, it is possible to discern the broad pattern of management over a number of years, in this case to the beginning of the twentieth century. To validate this particular approach some of the results have been verified against reliable written and oral records.

4.5.1 Nature of the forest

The ancient semi-natural areas of Wyre Forest were generally identified as relatively homogeneous stands of high forest oak (FIGURE 4.5.1.1). However, this apparent uniformity was broken up by a rather different woodland associated with springlines, brooks and stream valleys. Furthermore, underlying the seemingly monotonous stretches of high forest was a variation in woodland structure in both valley and plateaux woodlands (FIGURE 4.5.1.2).

Previous studies on Wyre (Salisbury 1925, Hickin 1971, Penistan 1963, Fincher's survey, NCC 1976, NNR Management Plan, NCC 1989) lacked the detailed description of forest structure and so provided little evidence of past management practices. The demise of coppice management coupled with the influences of the first and second World Wars brought about the loss of both management continuity and of uniformity in forest pattern. Since the second World War attempts have been made, most noticeably on Commission land and areas under the management of the Economic Forestry Group, to bring the broadleaved woodland under ordered management again. However, sizeable areas of the forest still remained in an apparently semi-neglected state and it was here that a palimpsest effect could be seen with aspects of the traditionally managed woodland still in evidence. Different ownership and management in various parts of Wyre had created a patchwork of forest structure.

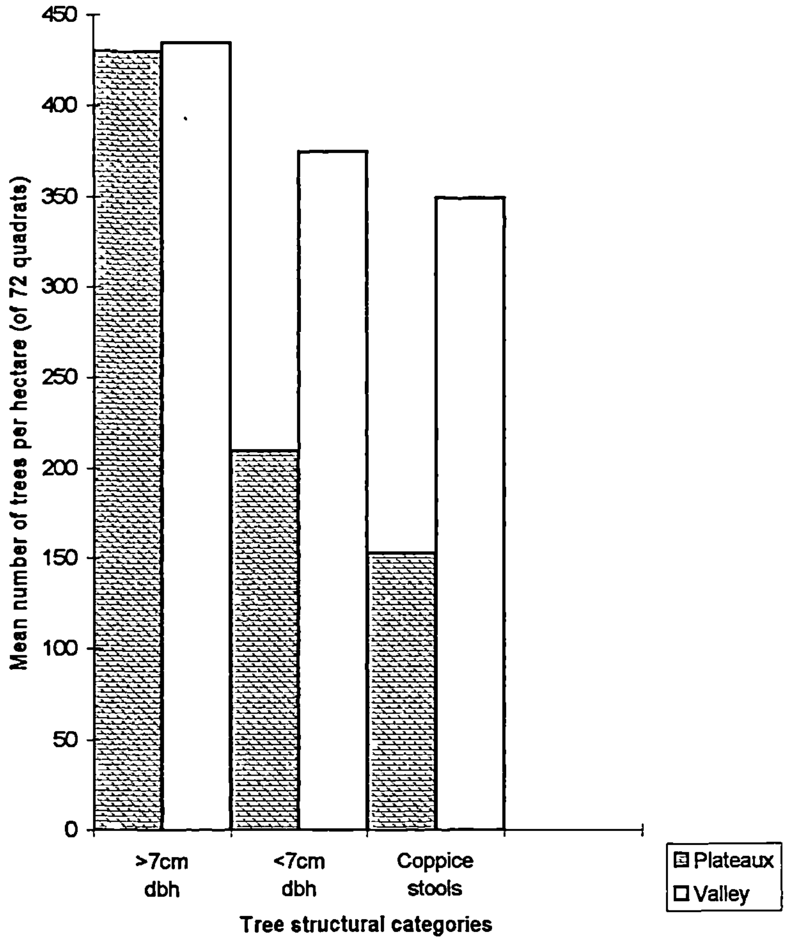
FIGURE 4.5.1.1 Tree species composition of oak woodland - Wyre



Category of "other" includes hawthorn, rowan and hazel..

(Values are given as proportion of the total number of stems in 72 quadrats.)

FIGURE 4.5.1.2 Structural composition of plateaux and valley woodlands - Wyre



4.5.2 Comparison of valley and plateaux woodlands

The density of trees (both standards and stools) in valley woodlands was significantly higher than it was in oak woodland on the plateaux (TABLE 4.5.2.1).

TABLE 4.5.2.1 Comparison of tree density between valley and plateaux woodland.

PLATEAUX WOODLAND		VALLEY WOODLAND	
Number of samples = 53 Quadrat size = 14.1 x 14.1 m		Number of samples = 27 Quadrat size = 14.1 x 14.1 m	
Total number of trees = 608	Mean number of trees per 200m2 = 11.5	Total number of trees = 440	Mean number of trees per 200m2 = 16.3
SD = 8.1	SE = 1.1	SD = 14	SE = 2.7
CL = 2.15	Range = 9.35-13.65	CL = 5.3	Range = 11.00-21.60
P = 0.028.	Calculated t	value = 2.01	which is significant

SD = Standard Deviation; SE = Standard Error; CL = Confidence Limits.

Whilst the confidence limits for both types of woodland show some overlap, when the data is tested using Student's t-test the number of trees in valley woodland is significantly higher than it is for plateaux woodland. The greater spread of density values for the valley wood data indicated a less uniform forest structure, whilst the oak woodland appeared to have a more regular structure possibly as a consequence of more systematic forest management.

If the woody components of both plateaux and valley areas are grouped into the structural categories coppice stools and mature trees, (TABLE 4.5.2.2) and then analysed using Chi-square (the degree of variance for stool density values for both habitats was significantly different which ruled out the use of Student's t-test), a more precise distinction in forest structure between the two woodland types is observed. In valley woodland the density of stools was much greater than on the higher ground (calculated x^2

value was 116.8; critical X^2 for a = .05 is 3.84 at df = 1). The number of trees with a dbh greater than 7 cm but less than 25 cm was significantly higher in plateau woodland (calculated X^2 = 20.57, critical X^2 = 3.84 for a = .05 at df = 1). However, there was no significant difference between valley and plateau woodland in the number of trees larger than 24 cm diameter at breast height, (X^2 = 1.28, critical value for X^2 = 3.84 at df= 1).

TABLE 4.5.2.2 Comparison of plateaux and valley woodland structure

Plateaux woodland		Valley Woodland	
Number of samples = 53 Quadrat sample = 14.1 x 14.1 m		Number of samples = 27 Quadrat sample = 14.1 x 14.1 m	
Total No. of stools = 208	Mean No. of stools/200m^2 = 3.9	Total No. of stools = 271	Mean No. of stools/ 200m^2 = 10.0
Tot. No. Of trees >7cm dbh = 493	Mean No. of trees/200m2 = 9.3	Tot. No. of trees > 7cm dbh = 164	Mean No. of trees/200m2 = 6.07
Tot. No. Of trees > 24 cm dbh = 178	Mean No. of trees/200m2 = 3.4	Tot. No. of trees >24cm dbh = 75	Mean No. of trees/200m2 = 2.8

These results suggest that more recent management of the plateaux woodlands was aimed at promoting the singling of stools, a practice which was not extended to the valley woodlands. The remarkable uniformity in density of large trees both within the stands and across the forest suggested a careful programme of selective thinning and silvicultural management throughout Wyre.

4.5.3 The structure of Wyre Forest

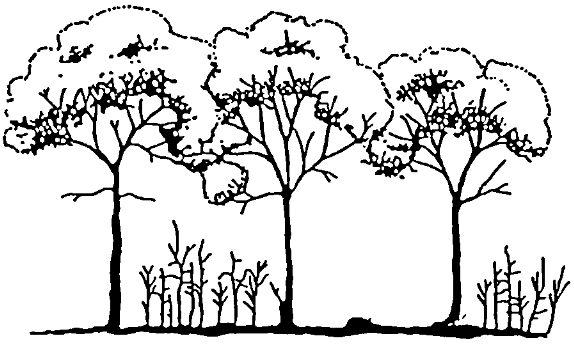
Woodland stand types

The practice of singling, removing all but one of the poles from a coppice stool so that the coppice can return to high forest, is storing (Packham et al., 1992). By the end of the last century much of the oak coppice was being stored and now forms a distinctive mature form of high forest - A, Single-stemmed high forest (FIGURE 4.5.3.1). In the Wyre two or three stems per stool were sometimes allowed to persist, giving rise to the second category of the four structural categories of deciduous woodland found in Wyre: B, Semi-stored coppice with 2 or more stems per stool. In a number of instances during the last war whole sites were clear-felled and left without further management. Subsequently, these areas have evolved into dense, almost impenetrable, stands, quite distinct from the surrounding woodland and form the third category: C, Post-clearance regeneration. Finally, substantial areas of semi-natural woodland were managed until the 1940s as selective coppice-with-standards. Since then these areas have had very infrequent, rather *ad hoc* management. This particular type of woodland stand is considered to represent a stage between the traditionally managed woodland and high forest, giving the last of the structural categories: D, Neglected traditional woodland (FIGURE 4.5.3.1). In summary, the categories (Hobson 1995a) are:

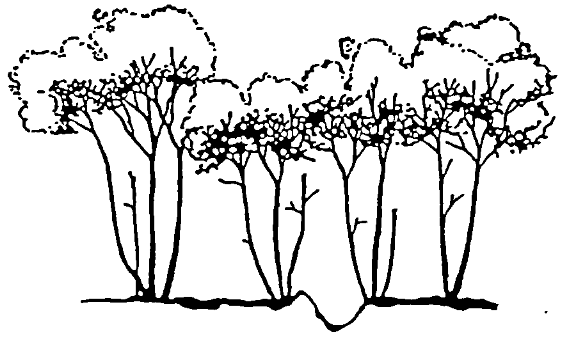
A - Single-stemmed high forest, largely derived from storing;
B - Semi-stored coppice with two or more stems per stool;
C - Post-clearance regeneration; and
D - Neglected traditional woodland.

The principal criteria for drawing these distinctions were the density of trees expressed as stems per hectare (FIGURE 4.5.3.2), and the proportion of birch which made up the canopy cover (FIGURE 4.5.3.3). Confidence limits calculated for the tree/stem density values showed some overlap for three of the stand-categories, A, B and D. There was little distinction between semi-stored coppice and neglected traditional woodland, and whilst there appeared to be a greater distinction between high forest and semi-stored coppice although this was not so apparent.

FIGURE 4.5.3.1 The four structural stand-types identified in Wyre Forest.



A SINGLE STOOLS, HIGH FOREST
Oak-85% of stand, remaining- small birch
Stocking density, 150-300 trees per hectare for oldest stand, dbh 30+; up to 1000 trees per hectare for younger stands

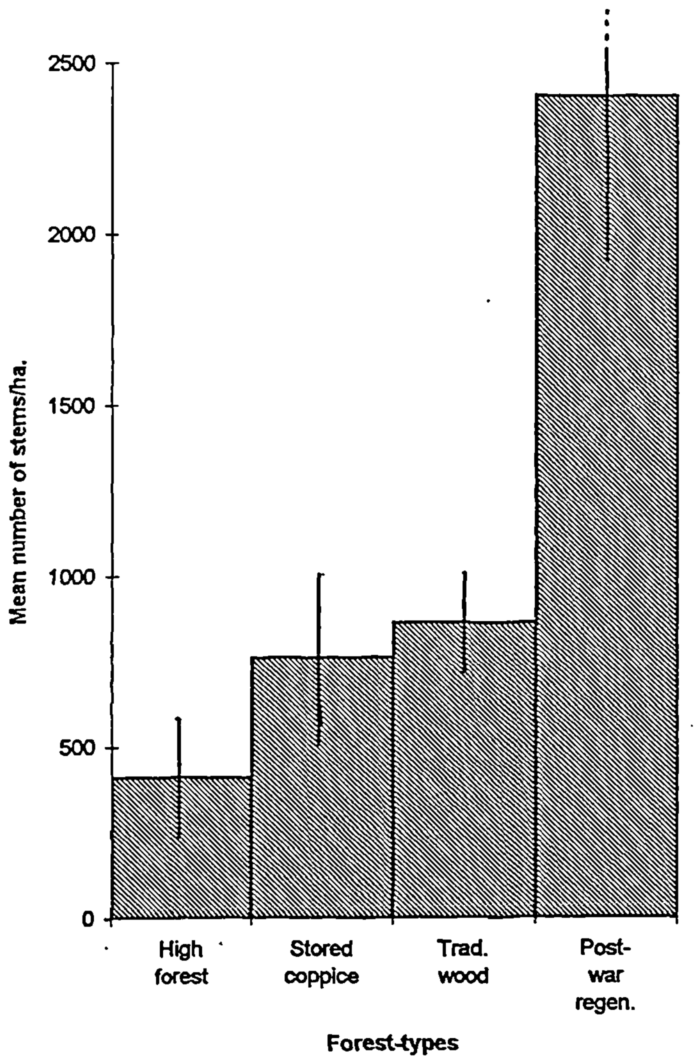


B STORED COPPICE
Oak-85% or more of stand, remaining trees - birch, both sapling & mature.
Stocking density, 500-1200 stools per hectare.

C POST CLEARANCE REGENERATION
Oak as little as 60% of the stand.
Stocking density 1000-2500 trees per hectare

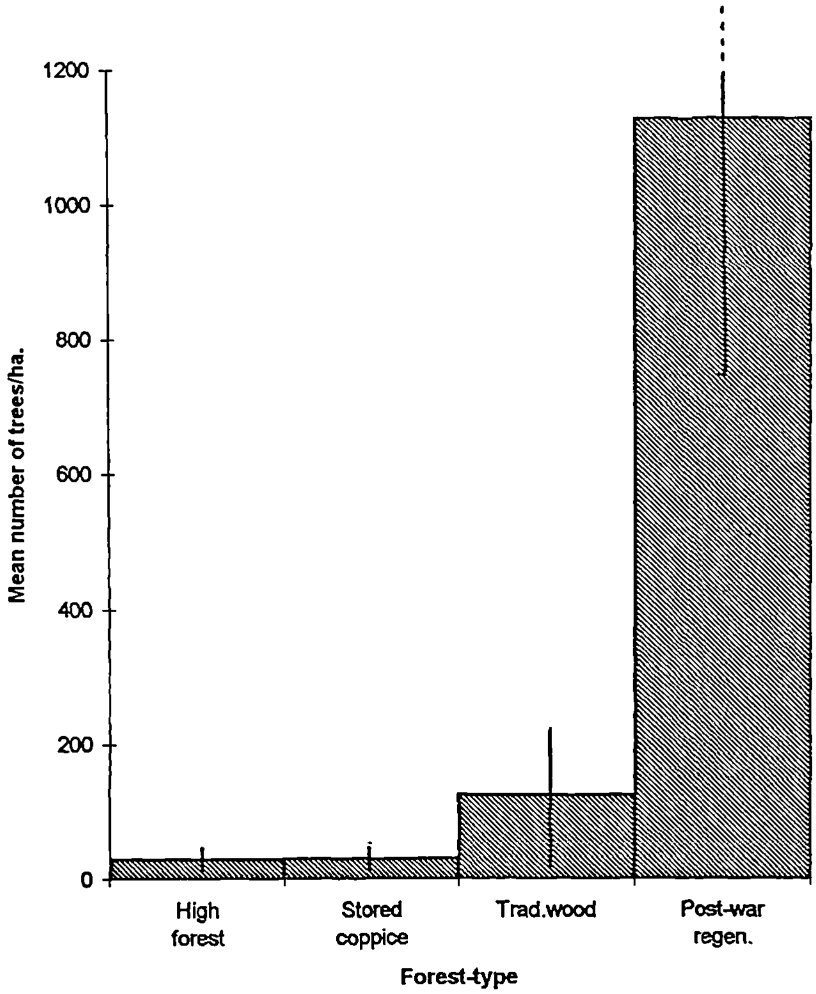
D NEGLECTED TRADITIONAL WOODLAND
1) valley woodlands
Oak - 15% of stand, remainder - hazel & alder
Stocking density, 450-600 stools per hectare, 300 standards per hectare.
2) Plateaux woodlands
Oak-80% of stand, remaining - young & mature birch. Stocking density - 500-800 trees per hectare.

FIGURE 4.5.3.2 Mean number of stems per hectare for four forest-types



(Vertical bars represent confidence limits)

FIGURE 4.5.3.3 The mean number of birch trees per hectare for four forest types - Wyre



(Vertical bars represent confidence limits)

However, a clear distinction existed between high forest and neglected traditional woodland. The most outstanding difference was the relatively large number of trees and stems in the post-war regeneration stands compared to the other three woodland types. The four woodland types also differed from each other in the numbers of birch present in the stands. When the stem diameter data was grouped into size classes further differences between the four woodland types became apparent (FIGURE 4.5.3.4). There was a significant difference between high forest and traditional woodland types in the number of small (0-8 cm dbh) stems (calculated X^2 was 8.9, critical X^2 value for a = .05 is 3.84 at df = 1),(Calculated F value was 1.832, variances were significantly different for all the stands. Student's t-test could not be used) As the discrepancy between traditional woodland and post-clearance woodland-types was even larger it was assumed that comparative differences between these two latter stands was also significant. A further comparative analysis between the high forest and traditional stand-types for the next stem size category - 9-16 cm dbh demonstrated a significantly higher number of stems in the latter stand (calculated X^2 was 25, critical X^2 value for a = .05 is 3.84 at df = 1). However, for the proceeding five stem-size categories any distinction between these two woodland stands was either too small to merit testing, or values were too low to allow for any effective analysis. This was not the case when comparing data for post-war regeneration stands and traditional woodland. When stem-number values were combined for the two classes - 17-24cm and 25-32cm dbh for analysis a significantly higher number of stems were recorded for post-war regeneration woodland (calculated X^2 was 270, critical value at 5% and 1 degree of freedom was 3.84). However, there was no significant difference in the number of larger stems between these stands (stem sizes - 33-40 cm and 41-48 cm dbh calculated X^2 was 0.1, critical value at 5% and 1 degree of freedom was 3.84).

These differences derive from historical management of the forest. By relating stem diameter classes to age (FIGURE 4.5.3.5), it was possible to conjecture what form of management had taken place in the forest over the last 50 years.

FIGURE 4.5.3.4 Comparison of forest structure between four oak/birch stands, Wyre

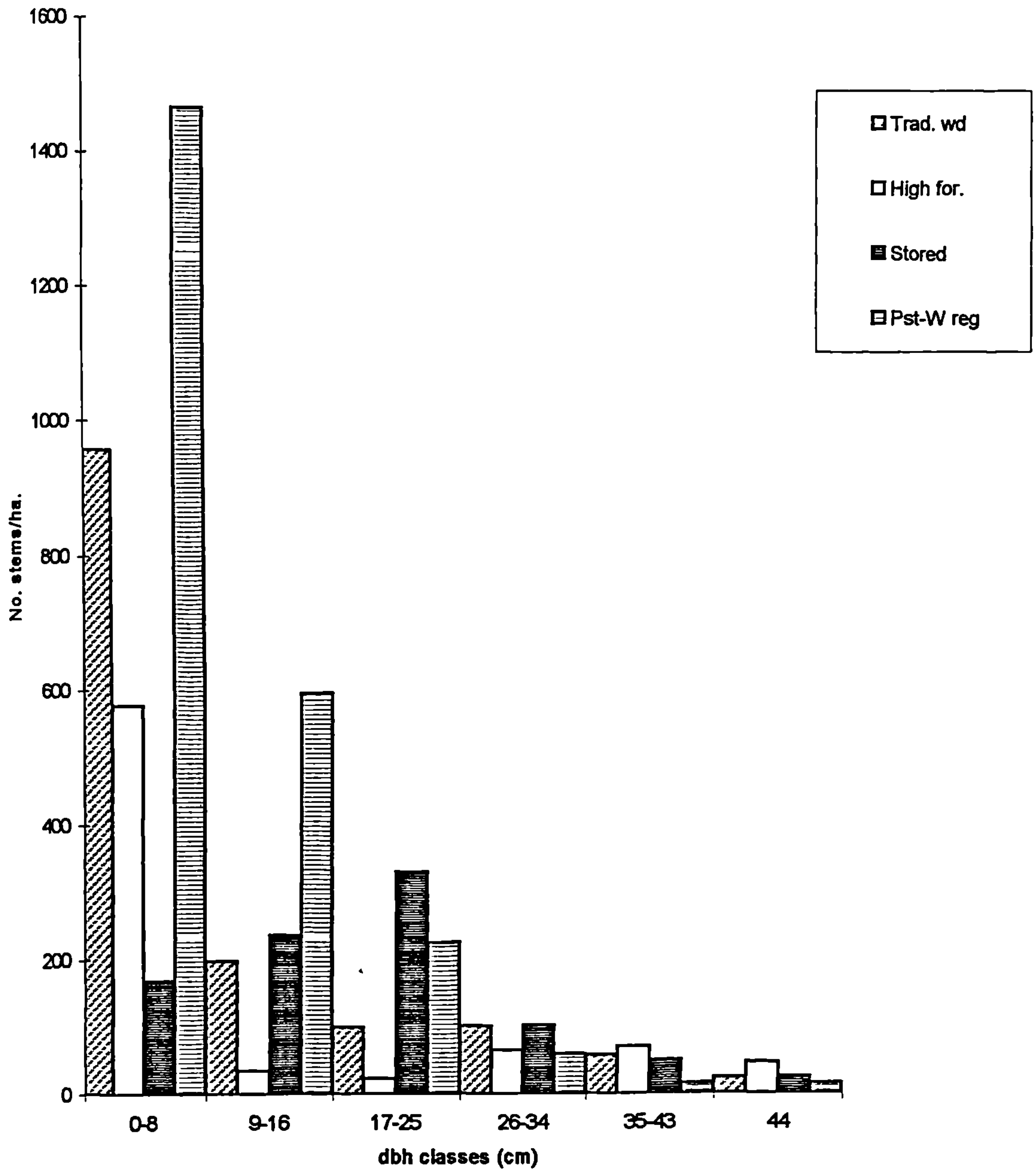
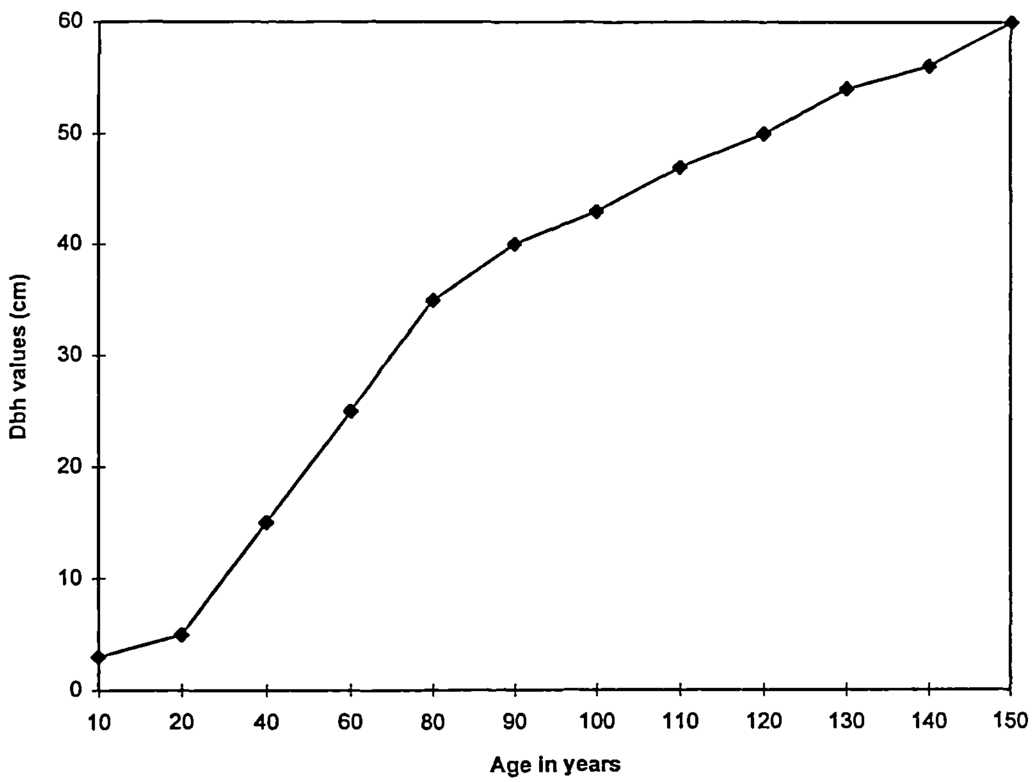


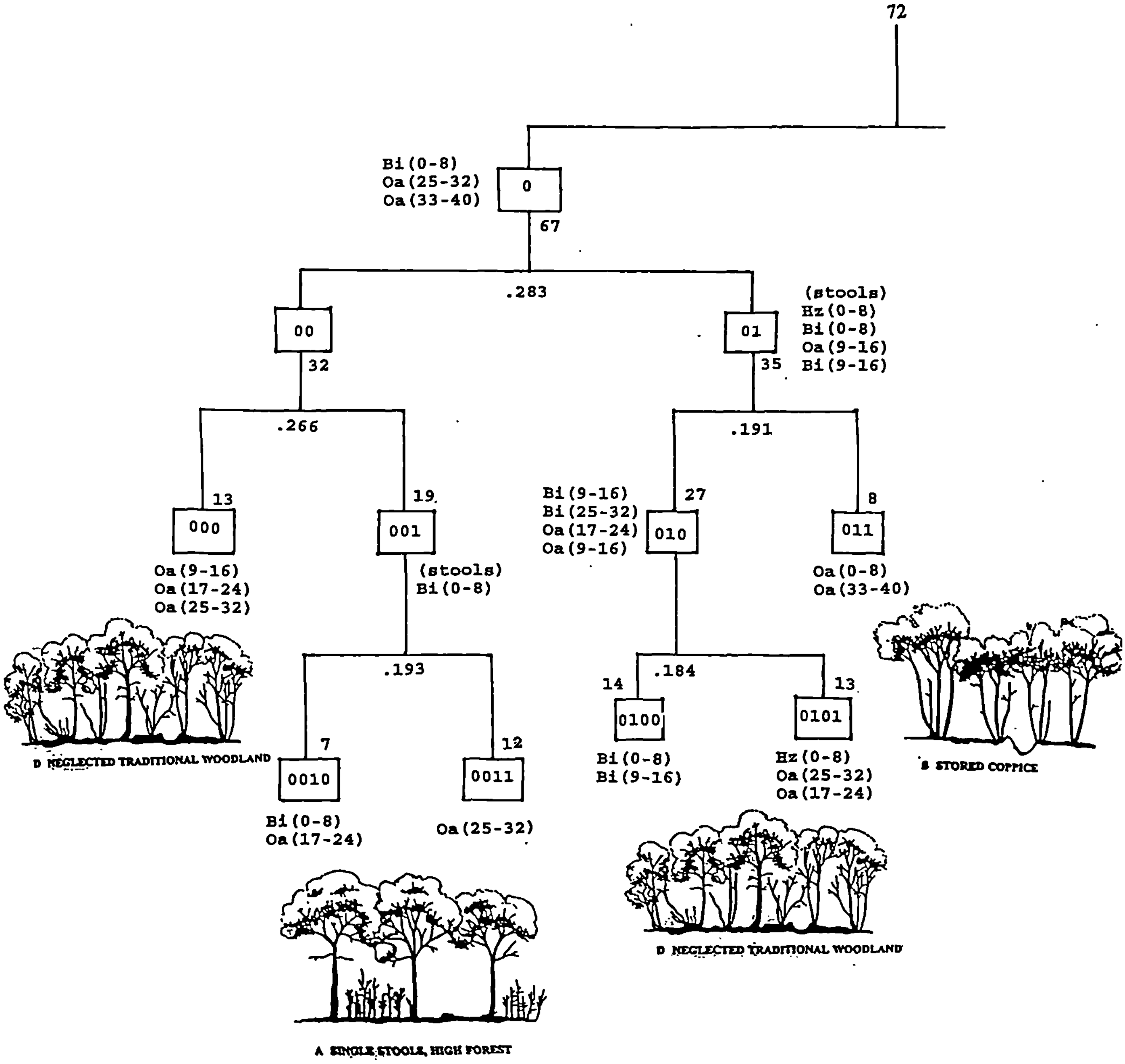
FIGURE 4.5.3.5 dbh/age correlation for oak in Wyre Forest (taken from Salisbury 1925 & BTCV 1980)



The comparatively low density of stems recorded within high forest stands (A) for the second and third size classes (Fig. 4.5.3.4) suggested a systematic tree thinning program since the last war (this was corroborated by two forest workers who described at least two thinning programmes over the last thirty years). In the case of traditional woodland and post war regeneration stands the comparatively large number of stems of both young and intermediate age suggested that a long period of neglect followed after WW2. Within the neglected traditional woodland (D), the lower density of stems and birch suggested that the extraction of timber may not have been quite so severe during the war and immediately afterwards as it was for areas of Type C stands (areas of post-war regeneration). These appeared to have been virtually clear-felled save for a few poles. Subsequently these cleared sites had very quickly developed a thicket of birch, oak and rowan, giving rise to the high density of stems in the absence of any significant post-war thinning. The proportion of birch in the canopy also indicated a state of management in the oak forest. Predictably, the highest values were for stands C and D, both of which were the least intensively managed areas of the forest. The other two woodland types - high forest (A) and young stored coppice (B), had been largely 'cleaned' of any birch since the war.

The two main criteria used, namely stem size classes and the proportion of birch in a stand, to identify the structural stands in the first instance, and then distinguish between them, was tested by incorporating all the data into a TWINSPAN analysis (FIGURE 4.5.3.6). The polythetic classification recognized three distinctive structural types: within the plateau woodland Group - 0: those of the TWINSPAN Group 000 and 010; stands of group 001; and stands of Group 011 (TABLE 4.5.3.1). A further analysis of stem structure for those stands in Group 000 and those in Group 0010 (FIGURE 4.5.3.7) confirmed a synonymy with the more arbitrary structural classifications described earlier, namely, neglected traditional woodland and single stool, high forest respectively.

FIGURE 4.5.3.6 TWINSPAN classification of forest structural stand-types, Wyre Forest.



The cladistogram represents the division of all oak/birch stands grouped in the polythetic Group 0. The remaining 5 samples in Group 1 were recorded in alder-oak stands in the valley areas and because of the distinct difference in composition of these stands they were not included in the study of forest structure.

TABLE 4.5.3.1 Frequency values for nine structural categories in 7 TWINSPAN Groups, Wyre

		POLYTHETIC GROUPS:						
STRUCTURAL CATEGORIES		0000	0001	0010	0011	0100	0101	011
0-8	cm dbh	5	5	5	7	14	12	7
9-16	cm dbh	5	6	3	4	7	10	7
17-24	cm dbh	5	8	2	0	2	9	7
25-32	cm dbh	5	8	0	7	5	11	5
33-40	cm dbh	3	8	7	12	8	10	2
T>7CM		5	8	7	12	10	13	7
STOOLS		1	1	2	6	14	13	7
bi 0-8	cm dbh	0	1	6	0	13	5	4
bi 9-16	cm dbh	2	0	0	1	2	0	4
Samples in each Group		5	8	7	12	14	13	8

The 67 samples of the total 72 quadrats analysed represent the oak-birch woodland and exclude valley woods samples

T>7 cm represents all single trees with a diameter greater than 7 cmdbh.

Bi = birch

Quadrats in Groups 0000, 0001 and 0101 were originally sampled from traditionally managed woodland

Those in Groups 0010, 0011 and 0100 were sampled in high forest.

Those in Group 011 were sampled in stored coppice woodland.

The TWINSPAN analysis failed to separate out the post-war regeneration stands; it grouped them together with samples from the traditional woodland. A possible explanation for this result is that ordination is unable to distinguish between two stands which show differences in the densities of stems but are very similar in structure.

FIGURE 4.5.3.7 a) Structural composition of high forest, Wyre. TWINSPAN Groups 0010, 0011, 0100

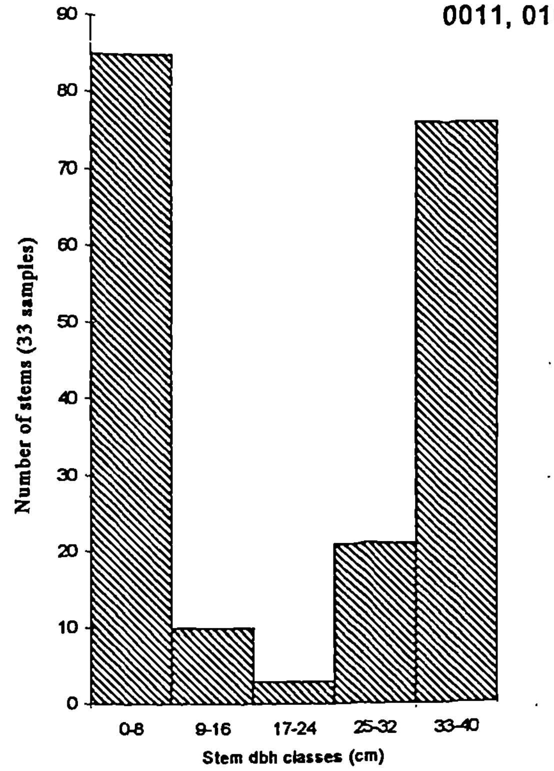
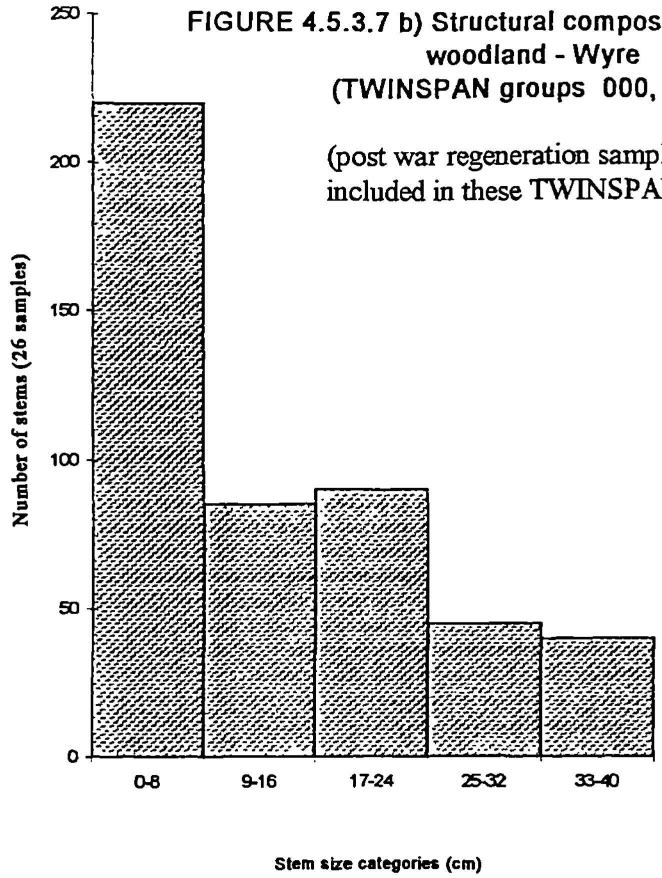


FIGURE 4.5.3.7 b) Structural composition of traditional woodland - Wyre (TWINSPAN groups 000, 0101)

(post war regeneration samples are included in these TWINSPAN Groups)



A. Single-stemmed high forest

This particular forest type commonly occurred throughout Commission land and areas formerly under the management of the Economic Forestry Group, as well as in a few tracts of woodland under private ownership. It was characteristically the most homogeneous stand-type in both age and species composition. Oak accounted for 85% of the woody component, and nearly all of the remaining 15% of tree cover was in the form of small birch regeneration (5-15 years old); all the larger birch trees would have been removed during the thinning programmes. The stocking density was related to the age of the stand and the soil conditions. Pre-war stands (trees with a diameter at breast height of 30+cm) were usually stocked at a density of 150 - 300 trees per hectare. Sites with singled stools dating back to WW2, and, or, stands on relatively poor soil "tumps" or ridges were more commonly stocked at higher density, up to 1000 trees per hectare in places.

B. Semi-stored coppice

Most of the semi-stored coppice sites formed small stands scattered throughout the forest and were distinguished by the predominant form of oak which grew as mature coppice stems, two or more to a stool. The stocking density was usually high, ranging from 500 to 1200 stools to the hectare. A high proportion of dead standing wood accounted for areas at the lower end of the stem density range. This dieback was possibly the result of self-thinning or the aftermath of Kermes quercus infestation (Harding & Hobson 1992). Oak accounted for about 70% of the trees while birch made up the rest as saplings and mature trees.

C. Post-clearance regeneration

As in the last case, sites of this category occurred sporadically throughout the forest usually as relics of war-time and early post-war clearances. Characteristically, they were mainly single-aged stands of both oak and birch, with the latter contributing as much as 65% towards canopy cover. Stocking densities on the earlier cleared sites were usually between 600 and 1000 trees per hectare, whilst on the more recently cleared sites (late 1950s-early 60s), tree and stool density ranged between 1000 and 2000 per hectare.

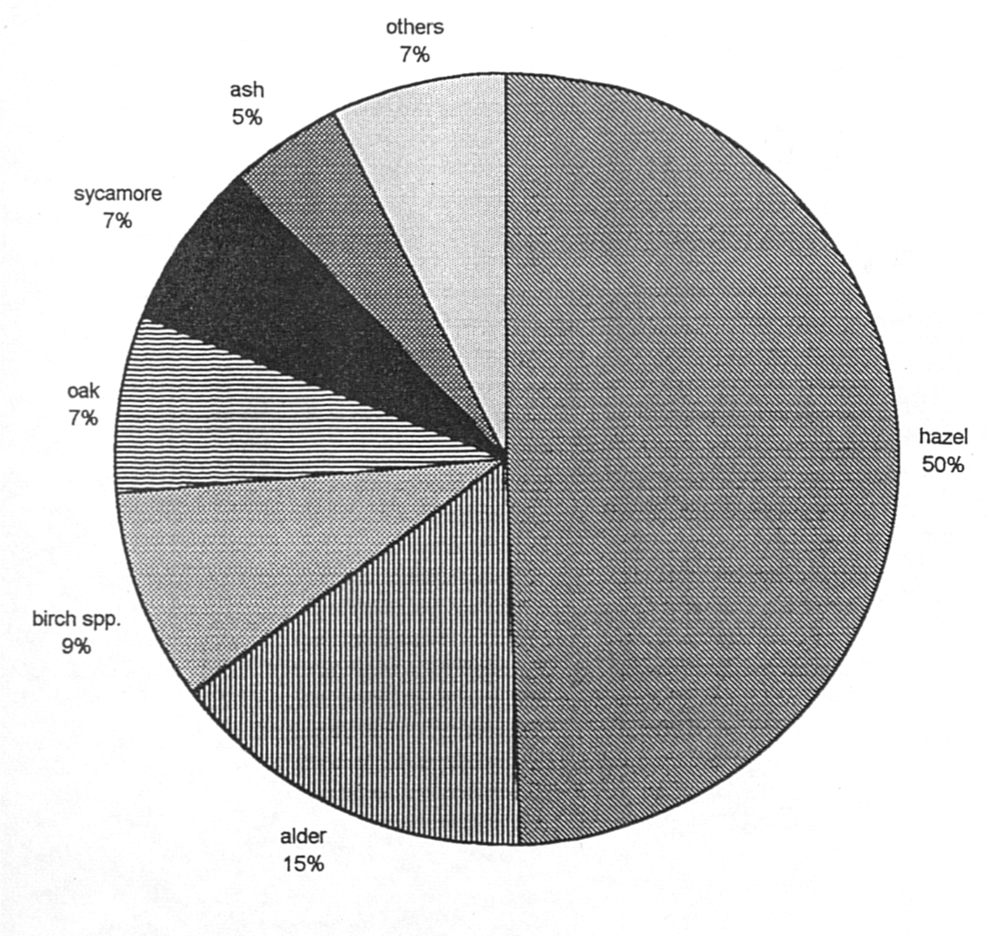
D. Neglected traditional woodland

This form of woodland occupied large tracts across the forest and showed marked variation in structure in respect of species composition and location. Within these areas of the forest remnants of traditional management could still be seen. Within this category were the springline and riparian woods which were made up of mainly hazel, alder, birch, oak and sycamore (FIGURE 4.5.3.8). The density of hazel stools was between 450 and 600 to the hectare whilst there were about 360 standard trees to the hectare, of which only 7% were oak. Many of the remaining trees were of downy birch, alder, sycamore and willow with only a few ash. Much of the ash was cut during WW2 (George 1987). The proportion of pre-WW2 trees in these riparian stands was significantly lower than in adjacent plateaux oak/birch stands (see above). These riparian woodlands had a more clearly defined pattern of coppice-with-standards.

Over much of the plateaux areas there was a mixture of oak and birch, the latter accounting for 20% of the woody component. The amount of holly in the wood also varied considerably; many of the mature trees had been cut out in the eastern region of the forest over the last 80 years (George 1987). However, towards the west into Doghanging Coppice, where the forest had a more "natural" look, holly accounted for 10-15% of the trees.

A characteristic feature of the traditional neglected forest type was the variation in age classes of tree, a lasting feature of past management practices. The average stocking density of trees which pre-date WW2 was 200 to the hectare. The remaining 60-80% of tree growth was made up of post-war regeneration of varying ages, 10-20% composed of 1950s-1970s growth while the remainder was more recent.

FIGURE 4.5.3.8 Percentage proportion of main tree species in valley woodland - Wyre



Regions with a greater proportion of early post-war growth occurred in the eastern half of the forest, while in the west into Doghanging Coppice a high proportion of coppice wood prevailed. On the upper valley slopes of the Dowles Brook and several other stream lines the stands were somewhat denser and lacked the influence of the older pre-war trees. Stocking densities in these areas were as high as 800 trees to the hectare and were made up of a range of different age classes. Species composition was much the same as it was on the plateaux although rather less birch was found (in places as little as 10%)

4.5.4 Management and species composition

Both early and recent management have played an important part in determining species composition in Wyre Forest. Observations of ecologically similar outlying woodlands drew attention to the impoverishment of species in the main block Wyre. A higher proportion of hazel, holly and wild service were found on the slopes of some of the peripheral woodlands; in the valleys of the outlying woods the stands were much more representative of a W7 Alder-ash community with numerous ash; the drier areas supported an ash-maple community with a diversity of canopy species including wild cherry (*Prunus avium*), small-leaf lime (*Tilia cordata*), hawthorn (*Crataegus monogyna*) and dogwood (*Cornus sanguinea*) in the shrub layer. In Wyre forest structure was considerably altered by harvesting during WW2. Nearly all the maiden trees were removed, leaving coppice and singled stools. Other less well documented activities during the war, including firewood collecting and small scale sheep grazing of the forest (George, 1987), may also have had a limited effect on the ecology of Wyre.

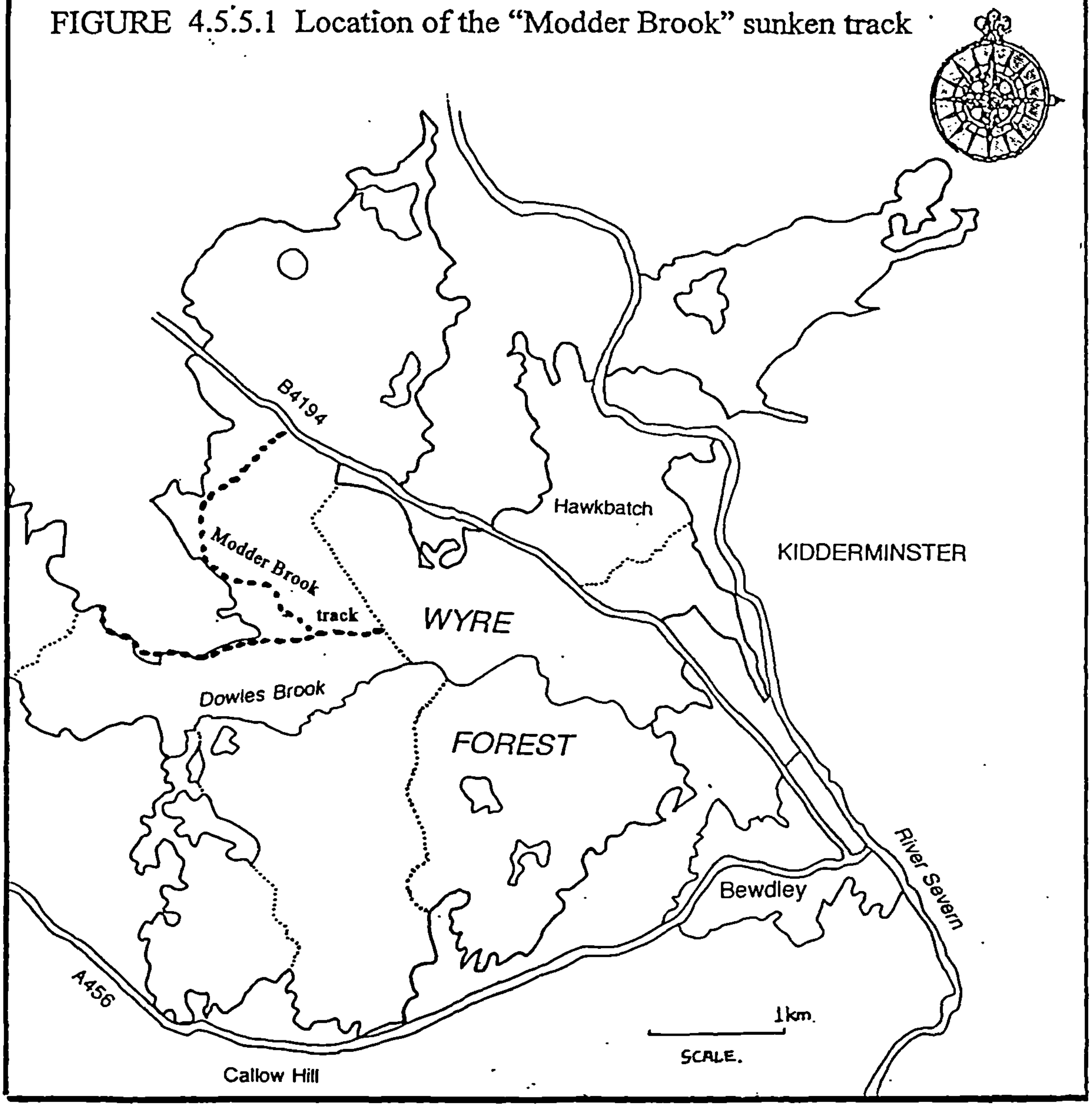
The distribution and abundance of holly and yew have declined over the last 50 years largely as a result of management (George 1987). This declining trend was most noticeable in areas of broadleaved woodland under Commission ownership, as borne out by the relatively high proportion of holly (10-15%) still surviving on internal woodbanks and in old windbelts. In areas of the forest which had escaped more rigorous management, in particular Doghanging Coppice, holly still persisted at densities similar to those of the old windbelts and woodbanks. A high proportion of yew still remains along water courses (Dowles Brook and Park brook) and in places along these brooks they occur at regularly spaced intervals where they appear to demark old coupe boundaries. The regular spacing of trees would suggest that they had been planted at some time in the past or thinned. This pattern of distribution is also apparent away from rivers but in association with deep sunken tracks. A rather more unusual relict of past activity was the presence of crab apple occurring in relatively high abundance throughout Longdon Orchard and along its woodbanks. Possibly these trees were all that remained of small holdings which were once orchard groves within Wyre. Major changes in the field-layer community have occurred as a result of past management practices. For example, bracken has spread and superseded "soft fern" (*Dryopteris* spp.) in many parts of the forest (George 1987).

4.5.5 The archaeological landscape

Few of the woodbanks formed impressive structures as they rarely exceeded 60 or 70 cm in height. However, peripheral banks appeared larger as most were accompanied along one side by a shallow ditch or sunken track. These banks were often set back two or three metres from old roads and only a few of them supported old stubs. One or two of the banks around the smaller woodlands (Upper Wood), and the internal coupes (New Parks), showed evidence of past hedging activity indicating the importance attached, in the past, to controlling livestock within the forest. Throughout the forest large springlines and brooks had been used to demarcate old coupe boundaries.

Other key features of the forest landscape were the sunken tracks, hearths, dew ponds and saw pits. Many of the tracks cut deep through the forest floor, in some cases over two metres (FIGURE 4.5.5.1). The depth of erosion suggested that heavy loads of wood were being extracted by use of horse-drawn timber wagons. Many of

FIGURE 4.5.5.1 Location of the "Modder Brook" sunken track



b) A schematic representation of the "Modder Brook" sunken track

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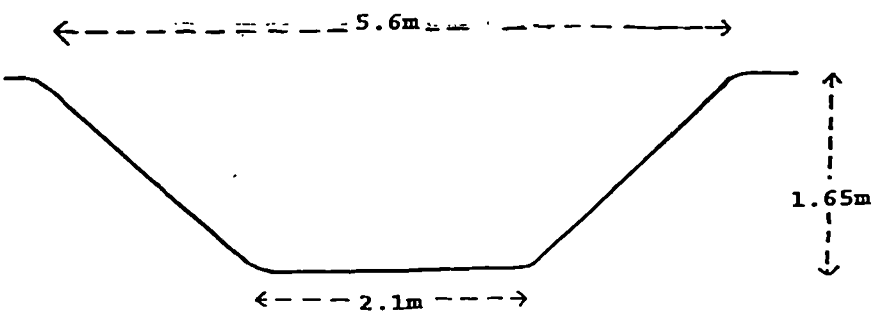
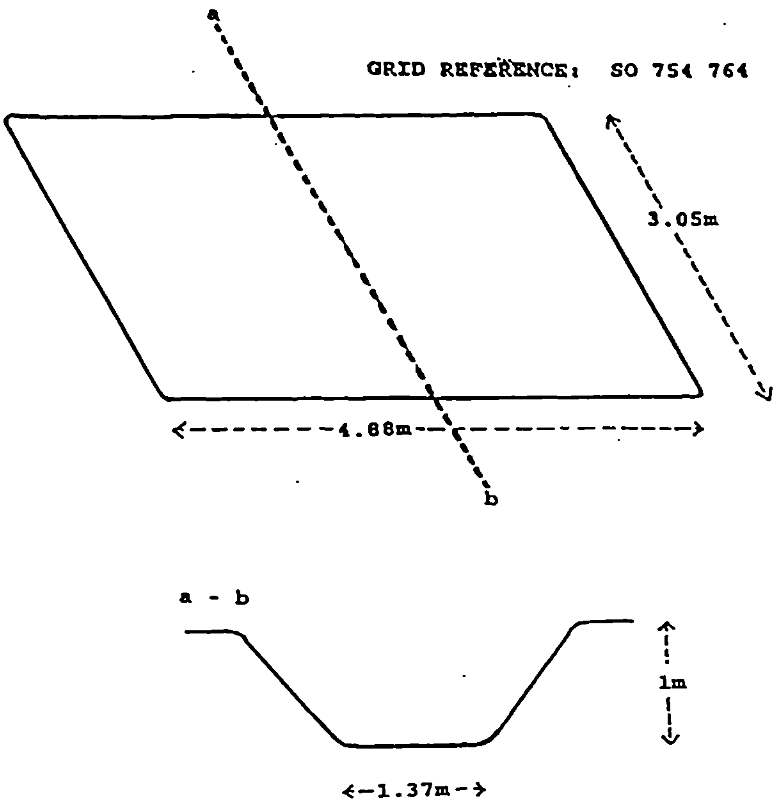


these tracks ran alongside woodbanks and cut down to brooks and streams which in the past were used as cross-over points between coupes. There was no evidence of tracks cutting across wood banks. Many of the charcoal hearths in Wyre Forest were cut out of banks alongside streams producing berm-like features. Some hearths further from a natural source of water were associated with dew ponds which today form prominent hollows (FIGURE 4.5.5.2). A number of other hearths were located close to sunken tracks and woodbanks, again, not far from a stream or brook. Finally, a number of saw pits remained scattered throughout the forest. These were generally two metres long, one and half metres wide and approximately one metre deep although the pit illustrated in the figure was a particularly large example (FIGURE 4.5.5.3). These saw pits were probably used to cut the pit props, the larger timber being processed in the saw *mills on the edges of the forest*.

4.5.6 Conclusions

Oral records (George 1990) have proved to be a valuable source of information on recent management practices and have provided additional knowledge not given in written accounts. Heavy reliance was put on historical documents to provide information on earlier activities. The field-based work has served to verify both written and oral records, and to interpret the impact of past activities on the forest ecology. A drawback to studies on forest structure is the extent to which the findings can be used in providing interpretative evidence for areas which have been subjected to frequent disruptive activity. The current evidence is usually a reflection of management since the last major disruptive event though some longer term effects may often be discerned. Fortunately, there are in Wyre areas of the forest which have suffered only little impact from disruptive activities since the nineteenth century and these sites form an important baseline on which to establish an understanding of past changes.

FIGURE 4.5.5.2 A schematic representation of a dew pond



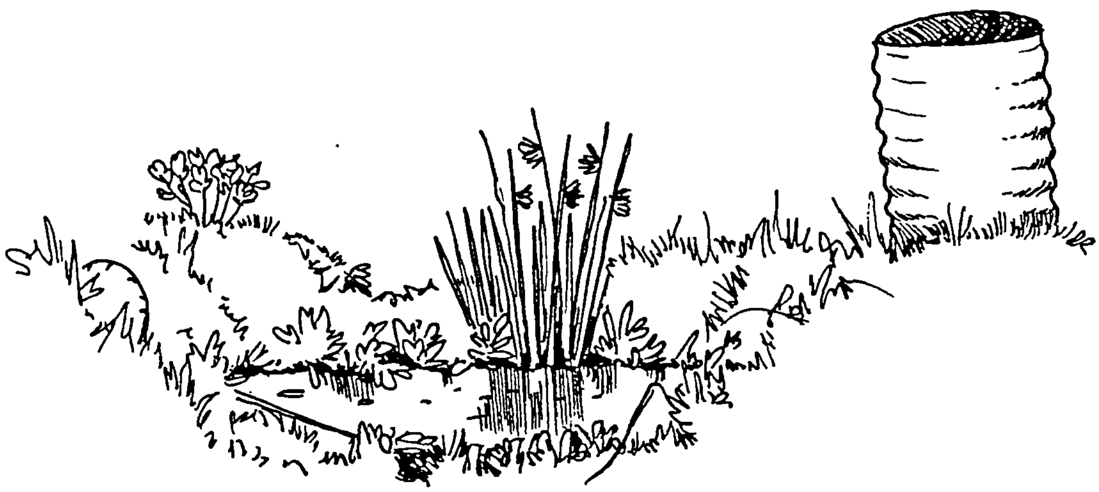
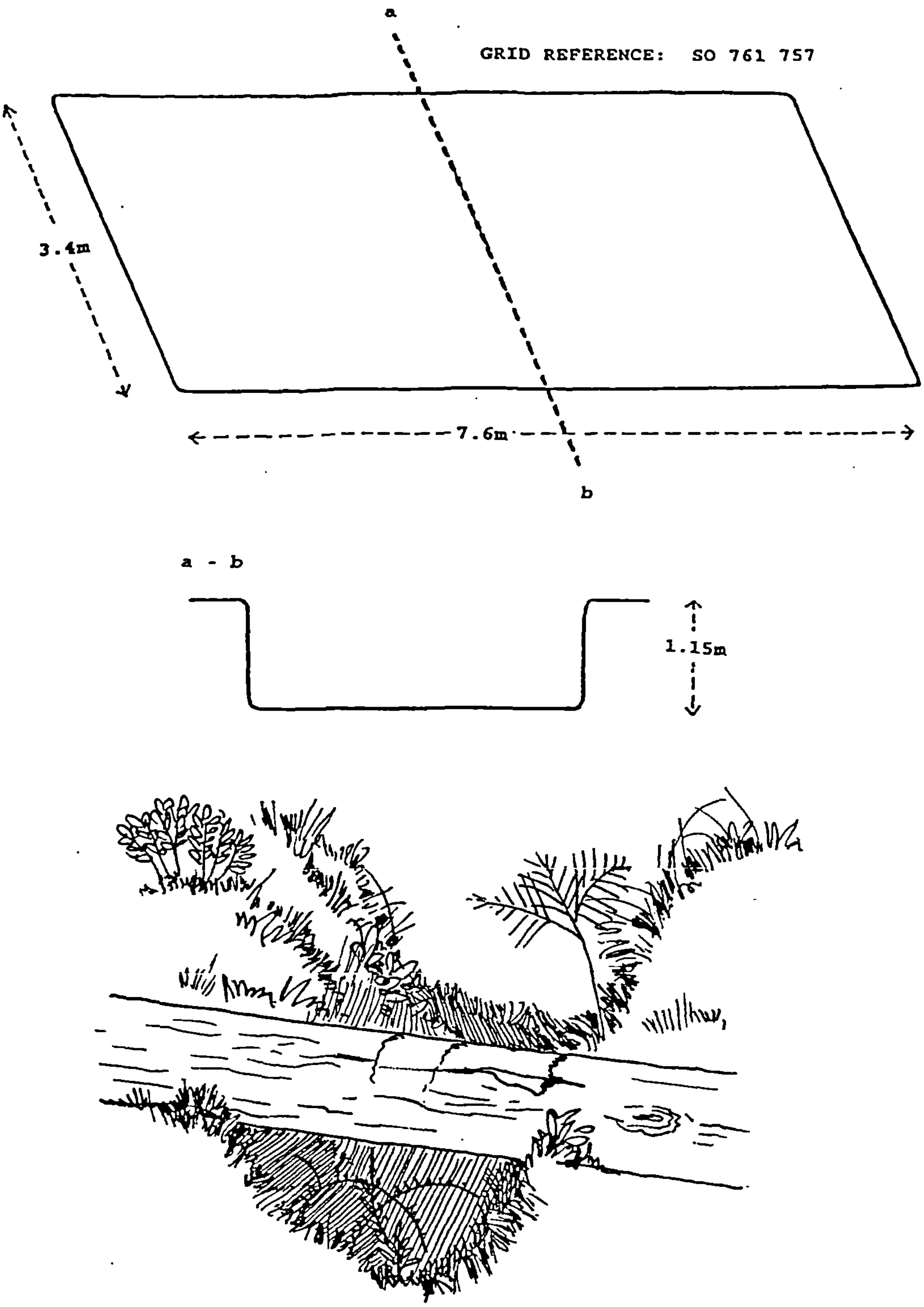


FIGURE 4.5.5.3 A schematic representation of a saw pit, Hitterhill



CHAPTER 5

THE PLANTLIFE OF WYRE FOREST

5.1 THE FOREST ECOSYSTEM

Five principal habitats were observed in Wyre Forest which were: plateau acid-oak woodland; valley mixed broadleaved woodland; silvicultural plantation; forest grassland and wetland. Of the woodland Salisbury (1925) identified two distinctive stand types. These were plateau acid woodland with its typical *Calluna vulgaris/Vaccinium myrtillus* fieldlayer; and valley oak woodland characterised by its diverse shrub layer and herb-rich fieldlayer. Salisbury also recognised that the leaching and translocation of mineral nutrients from the high ground to receiving sites on lower slopes and valley floors was one of the principal factors influencing the nature of the forest vegetation. This description, whilst somewhat over simplified, forms the basis to the ecology of Wyre.

5.1.1 An historical perspective

Salisbury (1925) made a reconnaissance of the whole vegetation of the forest; other studies made before or around that time included work done by Grant, 1926; Lea 1889; Lees 1867; and Rea 1923-31 (Hickin 1971). None of these other authors attempted to describe whole vegetation communities, their interest was usually focused on specific plants, in particular rare or unusual species. Another 50 years elapsed before any further attempt was made to classify the plant communities of the whole forest, although instructive computer studies of Seckley Ravine were produced by Packham (1975) and Packham and Willis (1976). A detailed vegetation survey undertaken by Fincher (1976) who applied the system of woodland vegetation classification devised by Peterken (1974, 1993). Fincher identified 9 major stand types in Wyre, which were:
western sessile oakwood - 6A, 6Ah, 6B, 6C;
ash and wych elm on base rich soil - 1A, 1B, 1C, 1D; and
alder woodland on stream banks 7A.

Fincher also found smaller stands of Maple/ash - stand type 2; ash/hazel - stand type 3; and
ash/lime - stand type 4.

Further work by Whitbread (1976) almost completed the list of stand types in Wyre with the following additions:

alder woodland on stream banks (acid/base rich) - 7Bb/7Bc.
Excluded from this final description are some of the less noticeable stands namely those associated with flushes. Two distinctive woodland types are *Betula pubescens/Molinia*, and *Salix/Carex* communities (both of which are detailed in the NVC, Rodwell 1991). Fincher's work, however, agreed with that of Salisbury (1925) in recognising the primary distinction between plateaux and valley woodland. Furthermore, Fincher highlighted the significance of Wyre with its position situated on the meeting point between east/west plateau acid oakwoods, and north/south communities associated with valley oakwoods (Sinker et al. 1985).

The National Vegetation Classification (Rodwell 1991), which also provides a comprehensive description of woodland stand types and the various sub-communities within each of the main communities, has been adopted for use in the present study. Many of the semi-natural communities of Wyre have, over the years, been modified by changes in the ecological status of the forest, and as a result of the introduction of a more modern form of silviculture.

This chapter gives a detailed description of the forest structure and the different vegetation types, and also includes references to plant species of particular interest.

5.2 THE WOODLAND COMMUNITIES

In this chapter the woodland communities of Wyre are classified on the basis of broad diagnostic features rather than by the National Vegetation Classification (NVC) system devised by Rodwell (1991). Although the forest vegetation showed close affinities with a number of NVC stand-types, there were also inconsistencies in that the plant communities were not so predictable in their composition.

Furthermore, many species from two different NVC stand-types were found growing together.

The following woodland communities of Wyre Forest are presented in order of occurrence, the most extensive type first:

Mixed oak woodland. Synonymy: NVC stand - W10 *Quercus - Pteridium aquilinum - Rubus fruticosus*);

Oak-heath woodland. Synonymy: NVC stand - W16 *Quercus - Betula - Deschampsia flexuosa*;

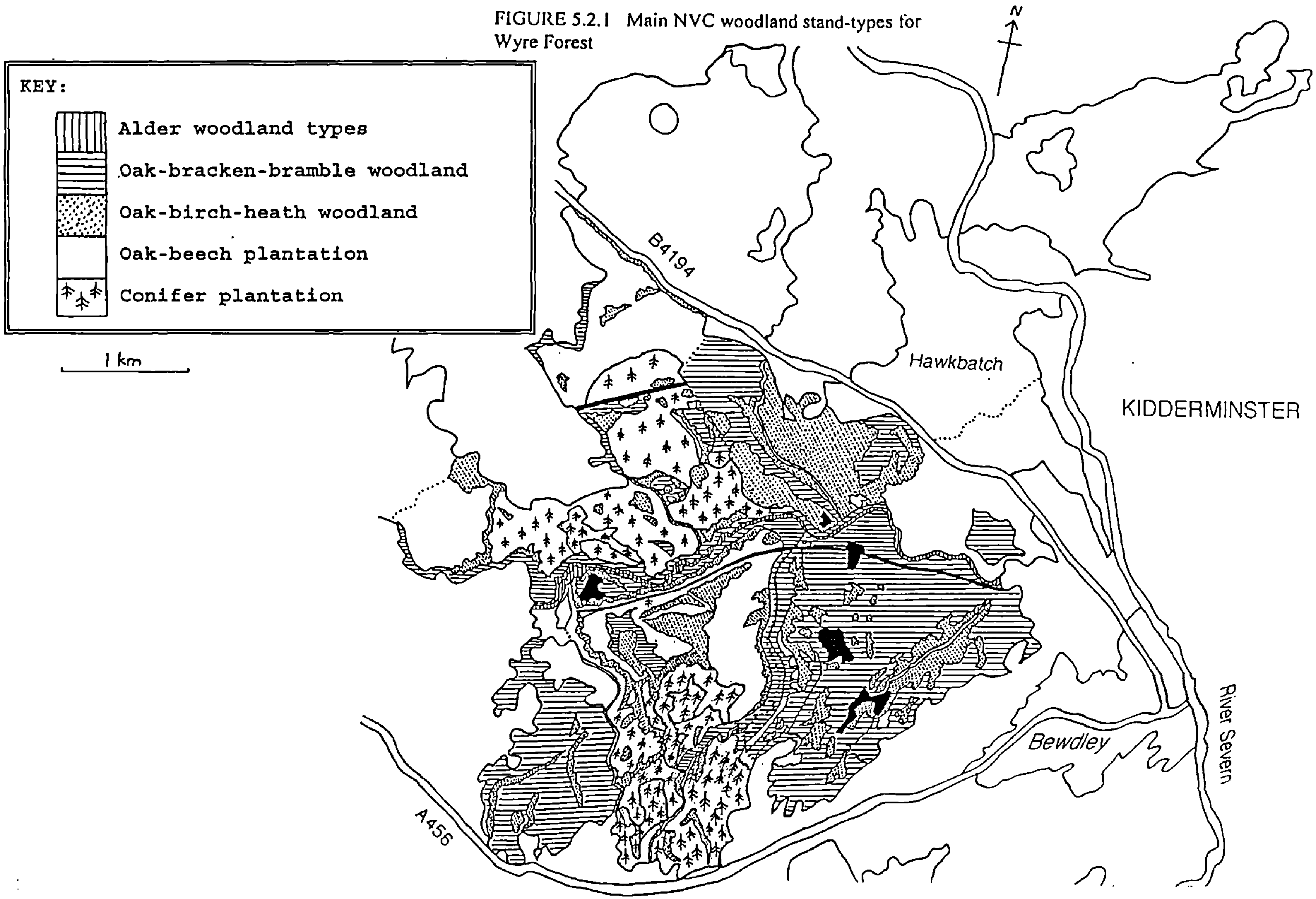
Alder-oak woodland. Synonymy: NVC stand - W7 *Alnus glutinosa - Fraxinus excelsior - Lysimachia nemorum*);

Ash-oak woodland. Synonymy: NVC stand - W8 *Fraxinus excelsior-Acer campestre-Mercurialis perennis*.

Birch-mire woodland. Synonymy: NVC stand - W4 *Betula pubescens - Molinia caerulea*.

These stand types accounted for approximately 40% of Wyre (FIGURE 5.2.1); the remainder of the forest consisted of silvicultural plantation and is described later in this chapter.

FIGURE 5.2.1 Main NVC woodland stand-types for Wyre Forest



5.2.1 Oak-heath woodland

synonymy:

NVC W16 *Quercus-Betula-Deschampsia flexuosa* stand.

Much of the high ground, plateau and ridge tops in Wyre Forest were dominated by oak-heath woodland. These sites were characterized by thin, sandy soils frequently overlying flaggy sandstone. Oak (*Quercus petraea*) accounted for 85% of the woody component of the woodland and much of the remainder was birch (*Betula pendula*). Furthermore, the trees often formed dense stands (TABLE 5.2.1.1) with little understory structure.

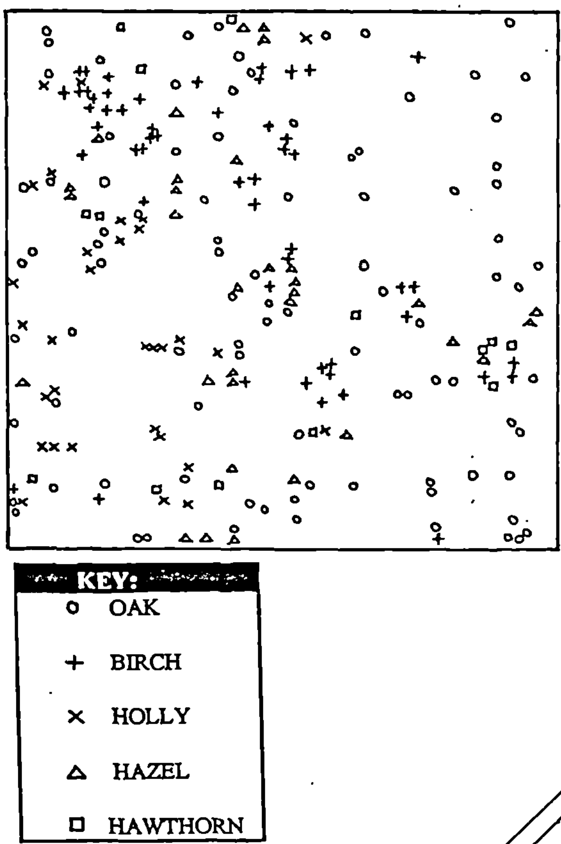
TABLE 5.2.1.1 Structural character of the oak-heath woods

The woody components of the forest sampled in a total area of 5800 m^2	Values 5800 m^2	Values ha^{-1}
Total number of oaks over 7 cm dbh	290	500
Total number of oaks under 7 cm dbh	20	34
Total number of oak stools	127	219
Total number of stems	651	1122
Total number of oaks recorded	437	753
Total number of birch trees	66	114

(Values are calculated from twenty nine, 200m^2 quadrats: total area is 5800 m^2. Values are then extrapolated to ha^{-1}.)

Despite the more recent management program of singling of stools the persistence of multi-stemmed trees made for a dense woodland canopy. The mean diameter of the singled poles and maiden trees within the sampled area was 19 cm (rounded down). The management of the forest over time did not appear to regiment in any way the spatial distribution of trees (FIGURE 5.2.1.1). Both mature oak and birch were irregularly distributed as were the seedlings in the

FIGURE 5.2.1.1 Distribution pattern of trees within a 50m x 50m quadrat, Dowles Brook, Forest Enterprise, Wyre



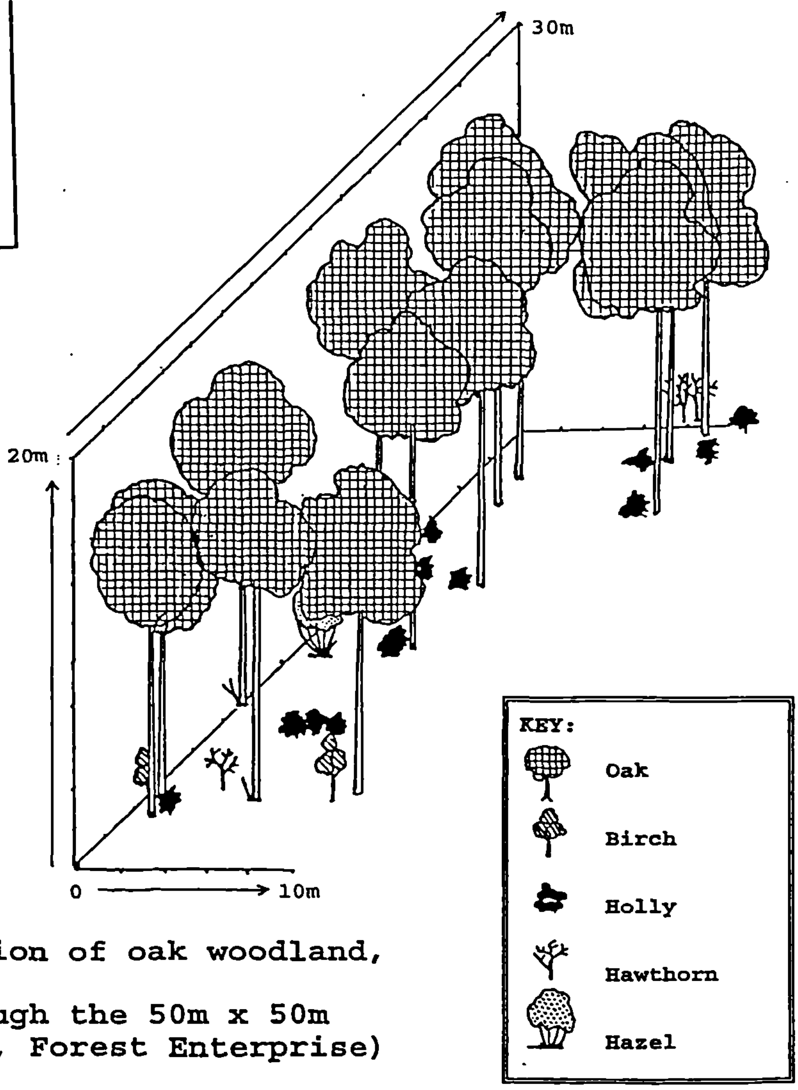


FIGURE 5.2.1.1 b)

Schematic representation of oak woodland, Wyre
(a belt transect through the 50m x 50m quadrat, Dowles Brook, Forest Enterprise)

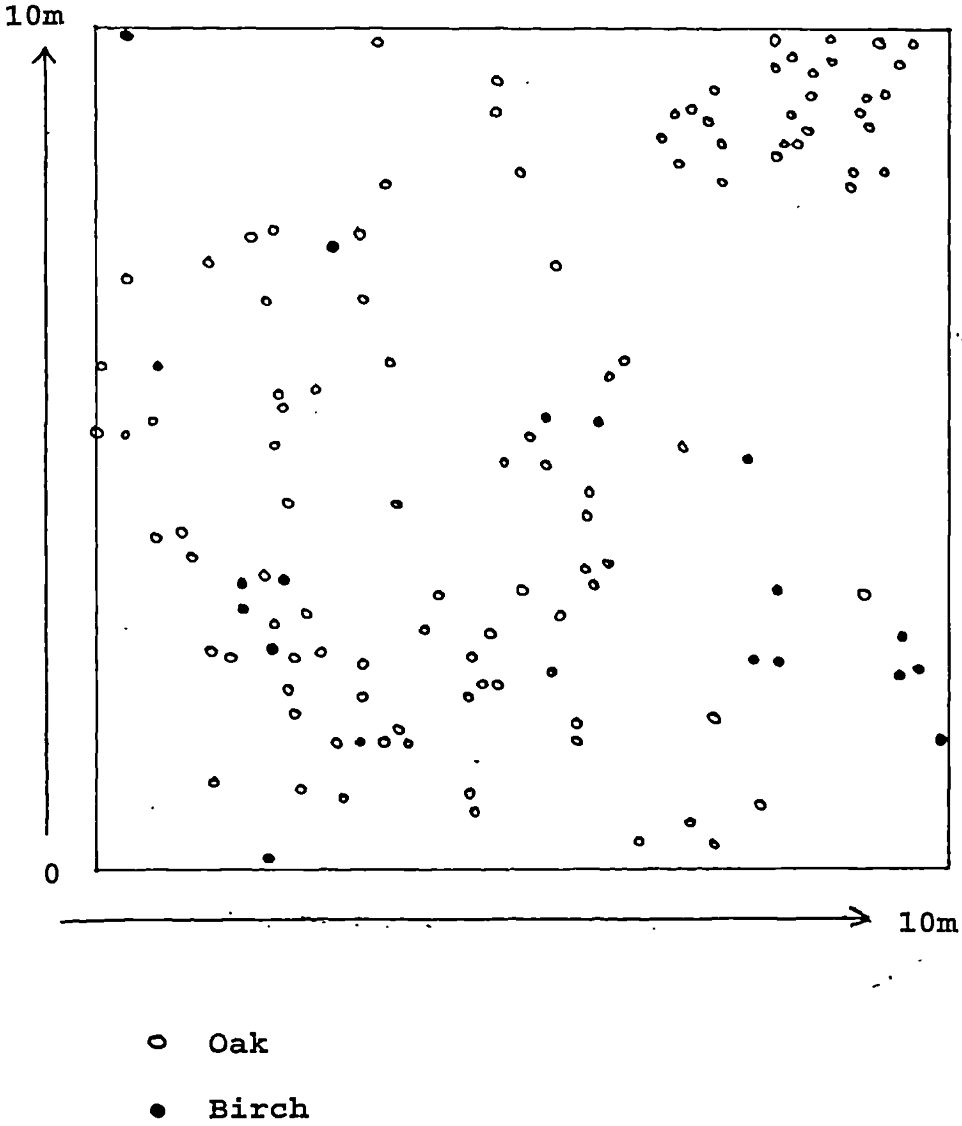
regeneration of both species. The distribution of oak and birch seedlings were observed to occur in a random pattern throughout the woodland (FIGURE 5.2.1.2). The young oaks were heavily browsed by deer which had effectively created a "turf" of seedlings. Whilst the number of seedlings was large almost none had shown progression beyond the establishment stage of growth. From a single quadrat sample (100 m^2) 129 oak and birch saplings were recorded with a mean height of 0.73m. Intensive browsing of the forest vegetation by deer had also reduced much of the holly growth to produce small "bonzai" trees (TABLE 5.2.1.2).

TABLE 5.2.1.2 Status of holly in Wyre Forest

72 (200 m^2) quadrats sampled on plateau areas	Holly present in 52% of the quadrats sampled
Total number of holly trees recorded = 111	
dbh trees (large enough to girth)	Dwarf trees (too small to girth)
Number recorded = 20	Number recorded = 91
Mean dbh of stem(s) = 5 cm (2 - 10 cm)	Mean height of tree = 43.2 cm (10 - 200 cm)

Two other important components of the woody formation were *Calluna vulgaris* and *Vaccinium myrtillus,* the latter species formed a constant in the fieldlayer of oak-heath woodland whilst *C.vulgaris,* which was more susceptible to heavy shade, was more sporadic in distribution.

FIGURE 5.2.1.2 Spatial pattern of oak and birch seedlings - Wyre Forest (within a 10m x 10m quadrat)



Oak-heath woodland was characteristically species poor; the main constant species were *Deschampsia flexuosa* and *Vaccinium myrtillus* (TABLE 5.2.1.3). Other common species included *Pteridium aquilinum* (which was recorded in 66% of the twenty nine sampled quadrats), and *Holcus mollis*, (present in 50% of the twenty nine sampled quadrats).

TABLE 5.2.1.3 Floristic table of species constants for oak heath woodland.

SPECIES	TEST DATA	CONSTANT TABLE FOR W16 (Rodwell 1991)
Quercus petraea	V (7-9)	II (1-10)
Betula pendula	IV (1-6)	IV (1-10)
Deschampsia flexuosa	V (4-7)	V (1-9)
Vaccinium myrtillus	V (1-8)	II (2-10)
Lonicera periclymenum	IV (1-4)	I (1-6)
Calluna vulgaris	IV (2-7)	II (1-9)
Rubus fruticosus agg.	IV (1-4)	II (1-7)

(Full floristic table presented in Appendix 5.2)

Areas of forest still covered in *Calluna* and *D.flexuosa* serve as a reminder of a once more extensive heather-dominated field layer (George 1987). During periods of deforestation and disruption in the 16th and 17th centuries, when large tracts of forest were bared of timber trees, extensive areas of woody heathland developed. This vegetation is still a characteristic feature of knolls and exposed ridges where much of the soil is extremely thin and impoverished and where it is not uncommon to find exposed flaggy sandstone. Some of the best examples of this type of vegetation were to be found on the Dowles escarpment and along the numerous ridges where erosion had exposed sandy facies. Similarly, heather had also successfully colonised sandy ridges exposed by forest road cuttings. In some areas dense thickets of heather reaching one metre in height dominated the fieldlayer; more open sites were colonized by *Deschampsia flexuosa*. The bilberry (*Vaccinium myrtillus*) appears to have been a prominent component of the field layer of oak-heath woodland in Wyre for some considerable time as it has lent its Welsh name to an old forest farm, "Uncllys" (llys being the Welsh interpretation for bilberry). The farm is clearly identified on the first OS map of Wyre Forest. As with the previous species bilberry favored areas around the base of knolls and both upper and lower sides of valley ridges, although it preferred deeper soils and was better able to tolerate more heavily shaded woodland than was *Calluna vulgaris*. Other species associated with this stand-type were *Dicranum scoparium, Galium saxatile, Melampyrum pratense, Teucrium scorodonia, Pteridium aquilinum, and Holcus mollis*. Rather more unusual yet apparent in its sporadic association with *Vaccinium* was the occurrence of *Convallaria majalis*. This plant was rare in the forest but occurred as often on heathy ground as it did in areas of bramble and bracken.

Over the last thirty years stands of *Vaccinium and D.flexuosa* have diminished in size with the gradual succession of the coppice wood towards high forest. The steady expansion of *Pteridium* and *Rubus fruticosus* throughout the forest has in many places superceded the more heath-loving species. This community change has been further promoted by modern forest management with the introduction of a high level of disturbance to both canopy and ground layers. Furthermore, heavy browsing of the vegetation by deer has left its impact on the forest. The stunted condition of the *Vaccinium* and *Calluna*, and the recent increase in the cover of *Pteridium*. (George 1987) is widespread.

5.2.2 Mixed oak woodland

Synonymy:

NVC W10 *Quercus-Pteridium-Rubus fruticosus agg. stand*

The majority of oak woodland in Wyre was that described in the NVC (Rodwell 1991) as the W10 - *Quercus - Pteridium aquilinum - Rubus fruticosus* stand-type, although nearly all the *Q.robur* was replaced by *Q.petraea* on the plateaux with much hybridization between the two species in valley areas. Throughout the forest this type of woodland was associated with deeper more loamy soils on plateau, hill slopes and valley edges. Oak was by far the commonest tree although one or two small stands had a high proportion of birch. The structure of the woodland was similar to that of the oak-heath although the proportion of single trees and coppice stools was significantly different (TABLE 5.2.2.1). The total number of trees (dbh > 7 cm) was less than it was for the oak-heath woodland (*calculated X^2 value was 12.64 for a= .05 at df = 1) and there were fewer coppice stools (calculated X^2 value was 16.74 for a=.05 at df = 1). More subtle differences in forest structure were also apparent (FIGURE 5.2.2.1). Whilst there appeared to be no difference between stands in the density of young stems (1-8 cm dbh), (X^2 value was 2.63 for a=.05, critical X^2 value = 3.84), for the intermediate stem size class, 9-24cm, there was a noticeable difference between mixed oak and oak-heath woodlands (calculated X^2 value = 18.6, critical X^2 value at a = .05 is 3.84). It is possible that a combination of poor soils and silvicultural management practices may have accounted for the overall larger number of intermediate sized stems in the oak-heath woodland. Foresters may have deliberately retained a higher stocking density of oak on these sites as pay-off for the poorer quality growth of the individual trees.

(* Chi square analysis was viewed as the most appropriate test to use for data which showed a significant difference in variance).

FIGURE 5.2.2.1 Comparison of forest structure between two stand-types - W10 & W16, Wyre

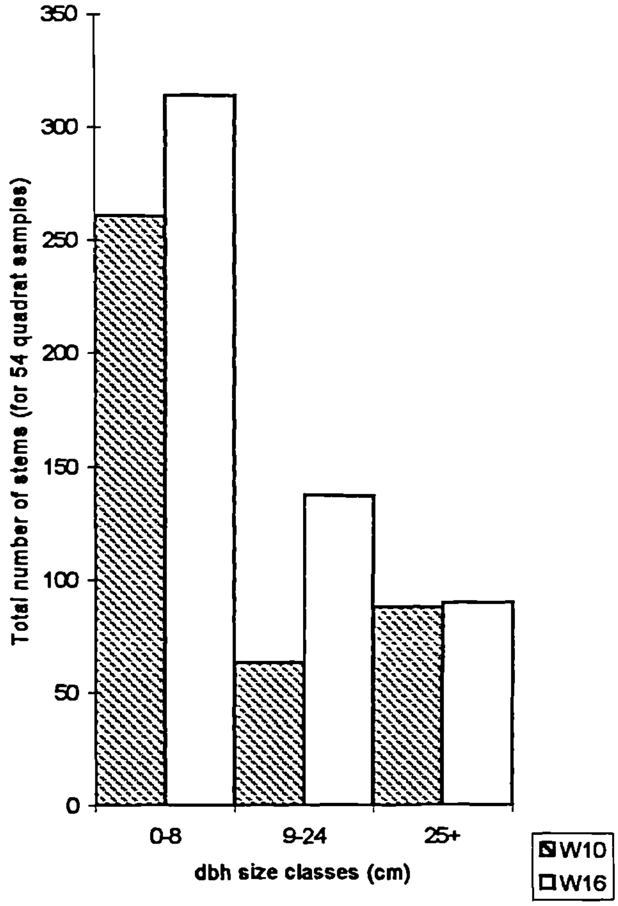


TABLE 5.2.2.1 Structural character of the mixed oak woodland

Woody components of the forest sampled in a total area of 6000 m^2	Values/ 6000 m^2	Values ha^{-1}
Total number of trees over 7 cm dbh	188	313
Total number of trees under 7 cm dbh	154	256
Total number of stools	50	83
Total number of trees recorded	342	570

Data is calculated from thirty quadrats - 200m^2 (total area sampled = 6000 m^2). Values are extrapolated for ha^{-1}

The herd of Fallow deer also played an important part in shaping the forest structure. Early stages of growth in all trees, but particularly in oak, were seriously impaired by browsing pressure of deer (FIGURE 5.2.2.2).

The understorey of these mixed oak woodland stands varied from total absence of cover to a well developed mixed cover. Shrub species included *Quercus petraea, Ilex aquifolium, Betula* spp., *Crataegus monogyna* and *Corylus avellana.* On the heavier soils *Malus sylvestris, Sorbus torminalis, Prunus avium* and *Taxus baccata* were more prevalent. Yew was a particularly prominent feature of the oak woodland in Wyre (TABLE 5.2.2.2) and was still a common and widespread species despite losses suffered between the 1920s and 1970s in forestry operations (George 1987). The distribution of yew was largely confined to remaining broadleaved areas of the forest. Furthermore, it appeared to favour the heavier soils in the forest, commonly occurring on springlines, valley slopes, clay lenses and wetland flushes as well as some wood banks (refer to Chapter 4).

Crab apple also appeared to have an unnatural distribution in the forest. Apart from a few trees sparsely distributed on heavy soils

FIGURE 5.2.2.2 Comparative performance of oak regeneration in browsed & unbrowsed vegetation, Wyre Forest

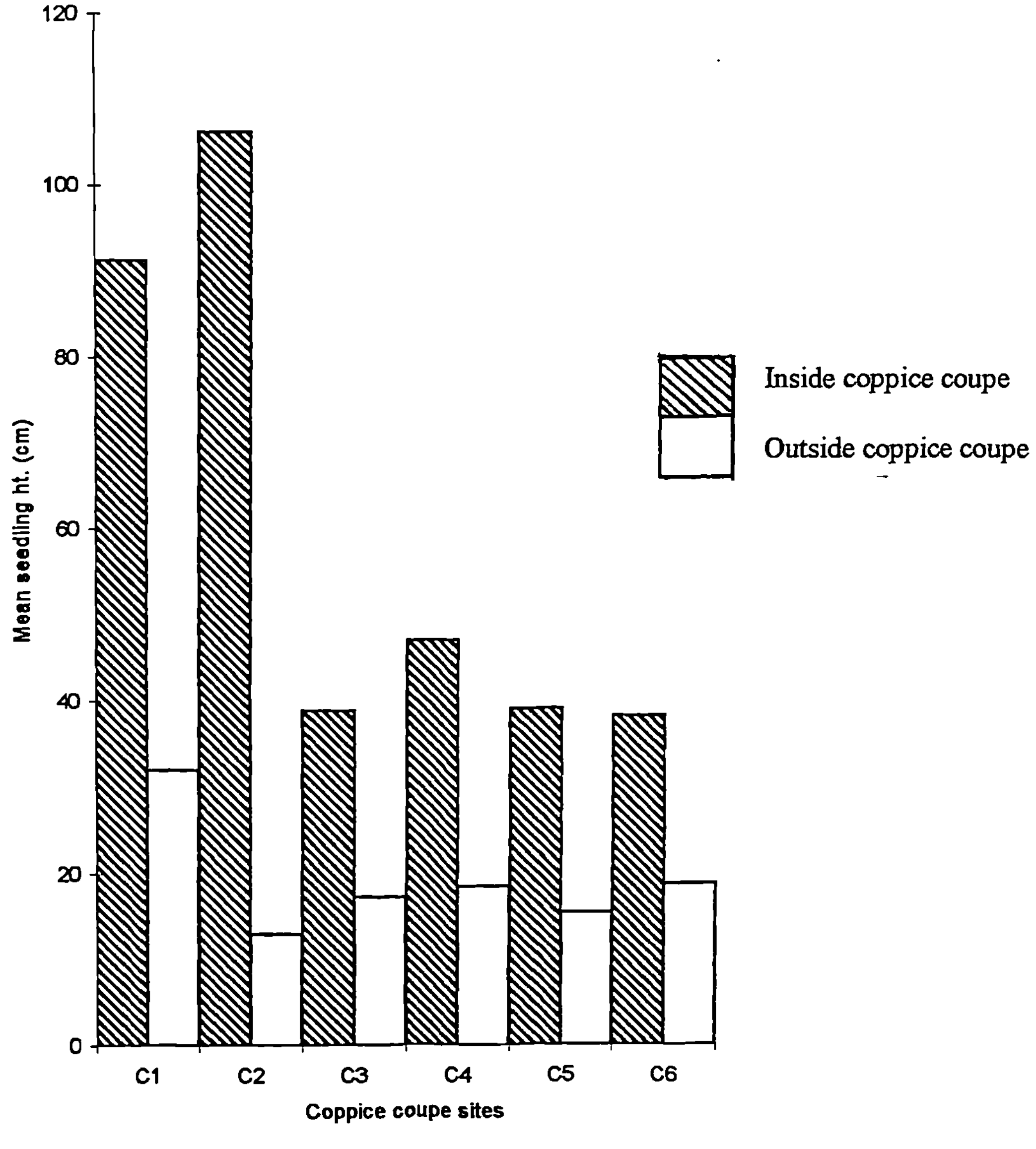


TABLE 5.2.2.2 Density of yew (*Taxus baccata*) in five broadleaved compartments.

comp.	Grid ref.	Size in hectares	Number of yew trees
Oak/beech 8072(a)	SO 745758	30.0	19
Oak/birch, 8062(a)	SO 746773	10.5	11
Oak/birch 8063(c)	SO 743771	5.0	5
Oak, 8067(a)	SO 729770	8.5	7
Beech 8080(b)	SO 745752	2.5	5

the rest appeared to be associated with old enclosures (Lodgehill Farm, SO 760765); along the edges of woodbanks (Longdon Wood, SO 748774); and in areas of the forest noted for their place-name such as Longdon Orchard, (SO 743775).

The field layer in mixed oak woodland was more complex and diverse than it was in oak-heath stands. The assemblage of constant species in the mixed oak woodland showed some parity with the floristic table given for the NVC W10 stand-type (Rodwell 1991), (TABLE 5.2.2.3). Typically, the more obvious species formed quite distinctive guilds throughout the mixed oak community. There were three such plant assemblages which are described in the following paragraphs.

TABLE 5.2.2.3 Floristic table for species constants of the mixed oak woodland stands.

SPECIES	TEST DATA	CONSTANT TABLE W10 stand (Rodwell 1991)
Quercus petraea	V (5-9)	II (3-10)
Betula pendula	IV (2-8)	II (1-10)
Holcus mollis	V (2-10)	II (1-10)
Rubus fruticosus agg.	V (2-7)	IV (1-10)
Pteridium aquilinum	IV (2-7)	IV (1-10)
Lonicera periclymenum	IV (2-4)	IV (1-8)

Pteridium aquilinum - Holcus mollis

Substantial areas within deeper, well drained soils of the forest supported an abundance of *Pteridium aquilinum* and *Holcus mollis*, in some places almost to the point of exclusion of other plant species. However, the different proportions of *P.aquilinum* to *H.mollis* frequently varied.

In woodlands which had experienced little disturbance both species occurred in low abundance and were equable with a range of other species of plants including *Hyacinthoides non-scripta, Luzula sylvatica, Hypericum pulchrum* and *Dryopteris filix-mas*. More disturbed woodlands often had a dense cover of *P.aquilinum* and in more heavily shaded areas, or on sites which had undergone bracken control, *H.mollis* often superceded *P.aquilinum* as the predominant species. Species associated with this stand-type included *Rubus fruticosus, Lonicera periclymenum, Teucrium scorodonia, Hypericum pulchrum, Agrostis capillaris, Viola riviniana, Hyacinthoides non-scripta* and *Luzula sylvatica.*

Pteridium aquilinum - Rubus fruticosus agg.

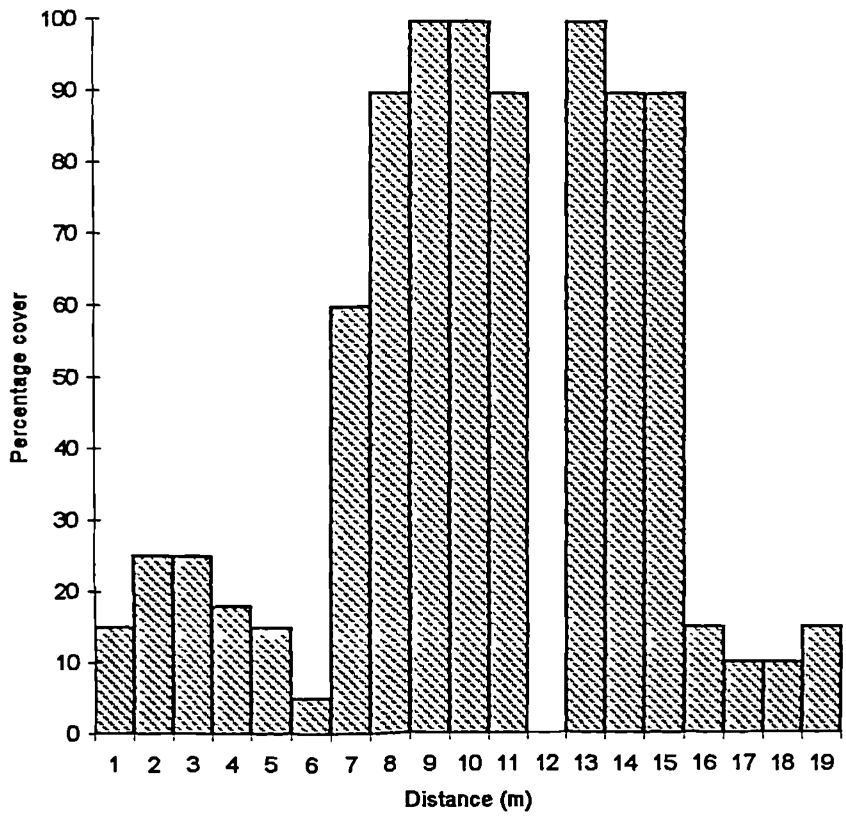
Woodlands which had a field layer dominated by *Pteridium - and Rubus* also showed considerable variation in the proportion of the most abundant species. On damper soil bramble was favoured where it was better able to compete with the bracken. Furthermore, feeding patterns of the Fallow deer (Dama dama) effectively altered the relative balance of co-dominant bracken and bramble, often favouring the former. This was particularly evident in areas where small exclosures had been erected as deer deterrents (FIGURE 5.2.2.3). Bramble also appeared to respond more positively to heavy disturbance of the kind often seen during forestry operations. Consequently there was vigorous growth of this species along extraction routes, ie., Lord's Yard Coppice track (SO 755 753), and in recently worked woodland sites. This is a trend often seen in other worked forests (Rodwell & Patterson 1994). Many plant species were influenced by the more direct impact of coppicing. The frequency of *Lonicera periclymenum* increased dramatically in the field layer of recently coppiced sites (FIGURE 5.2.2.4).

Plant species associated with the *Pteridium - Rubus* stand-type included *Lonicera periclymenum, Holcus mollis, Agrostis capillaris, Hyacinthoides non-scripta, Potentilla sterilis, Viola riviniana, Hypericum pulchrum* and more rarely, *Convallaria majalis*. Scattered throughout the bracken-bramble vegetation were concentrations of *Melica uniflora, Euphorbia amygdaloides* and *Viola riviniana.* These three species together marked the location of old traditional charcoal hearth sites where the underlying soil appeared to be carbonized with large nuggets of charcoal.

Corylus avellana - Deschampsia cespitosa association.

The lower valley slopes, edges of springlines, and areas of deeper loamy soils supported a more base-rich plant community. These woodlands were often well structured with a robust understorey composed of *Quercus petraea, Corylus avellana, Betula* spp. *Ilex aquifolium* and *Sorbus aucuparia.* Other species included

FIGURE 5.2.2.3 Percentage cover of Rubus fruticosus along a transect through a deer exclosure - Wyre



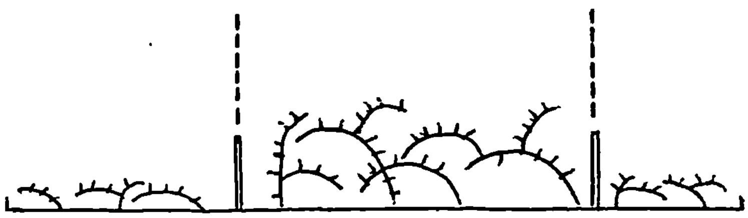
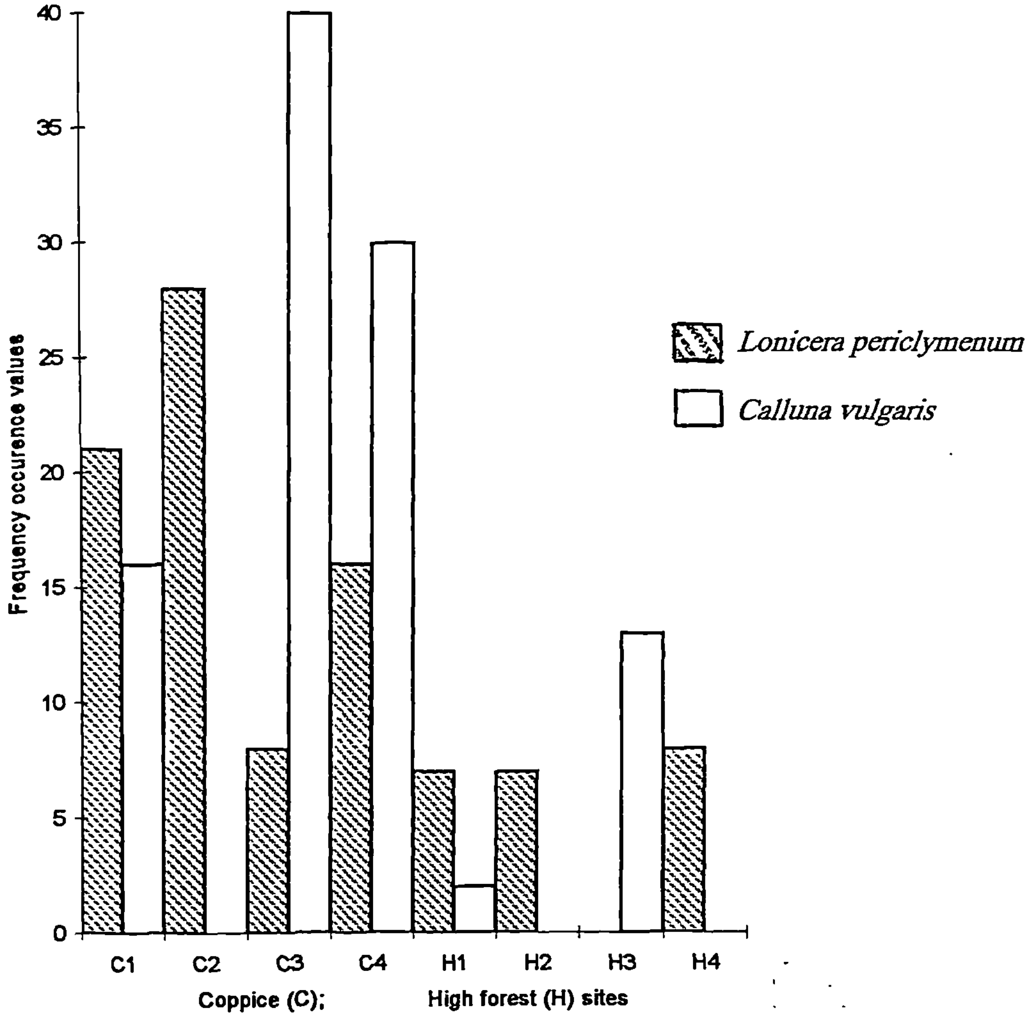


FIGURE 5.2.2.4 Comparative measure of frequency for two common species between coppice and high forest



Crataegus monogyna, Taxus baccata, Prunus avium, and *Sorbus torminalis.* It is unlikely that hazel-dominant oak woodland communities have always been confined to the valleys as small stands of hazel-under-oak were observed scattered throughout the forest on plateau ground (Nailings Coppice - SO 7175; Oxbind Coppice - SO 7474; Fastings Coppice - SO 7479; Kingswood - SO 7376; Eymore - SO 7779; and Lord's Yard Coppice - 7575). The emphasis in the four hundred year period between the early sixteenth and late nineteenth centuries on charcoal production would have promoted a more homogenous oak woodland at the cost of losing a more species-rich community. The fieldlayer was more diverse than those of the previous two vegetation types, although it was often sparse due to the dense canopy cover. Bare ground or leaf litter accounted for 20 - 55% of the ground layer (values taken from 5 NVC quadrat samples). The two constant species in this stand type were *Deschampsia cespitosa* and *Rubus fruticosus.* Associated plants included *Agrostis capillaris, Anemone nemorosum, Brachypodium sylvaticum, Euphorbia amygdaloides, Lamiastrum galeobdolon, Luzula sylvatica, Potentilla sterilis, Primula vulgaris* and *Viola riviniana.*

Towards the lower valley slopes and at the bottom of gullies the oakwood stands merged into riparian woodland. These thin ribbon-like habitats varied in extent from little more than 5m wide along springlines to 20m wide habitats on the larger brooks.

5.2.3 Valley and springline woodland

synonymy:

NVC W7 - *Alnus-Fraxinus-Lysimachia nemorum* stand.

The valley woodlands were easily distinguishable from the stands on higher ground because of the differences in structure and composition (Chapter 4). A higher proportion of saplings and coppice growth existed in the valley woods. The most prominent species in riparian woodland were *Quercus* hybrids and *Alnus glutinosa* . The latter species accounted for 43% (value calculated from twenty seven 200 m^2 quadrats), of all woody plants. The understorey was mainly composed of *Corylus avellana.* Other noticeable species in the wood included *Betula* spp., *Fraxinus excelsior, Acer pseudoplatanus* and *Salix cinerea*. There was only a small proportion of ash in the canopy as much of this species was removed during the WW2 (Penistan 1963, George 1987). Other shrubs which occurred more sporadically were *Viburnum opulus, Cornus sanguinea, Prunus spinosa* and more rarely, *Frangula alnus*.

The fieldlayer was variable, particularly between the larger brooks and smaller springlines. Along the springlines *Carex pendula* and *Carex remota* were often abundant; other associated species included *Blechnum spicant, Athyrium filix-femina, Filipendula ulmaria, and Primula vulgaris.*

The main brooks flowing through Wyre were characterised by intermittent alluvial berms (ledges) which had been extensively colonised by *Bromus ramosus, Brachypodium sylvaticum, Allium ursinum, Geum urbanum, Lamiastrum galeobdolon, Dryopteris filix-mas, Euphorbia amygdaloides, Filipendula ulminaria, Melica uniflora, Oxalis acetosella, Viola riviniana* and other species.

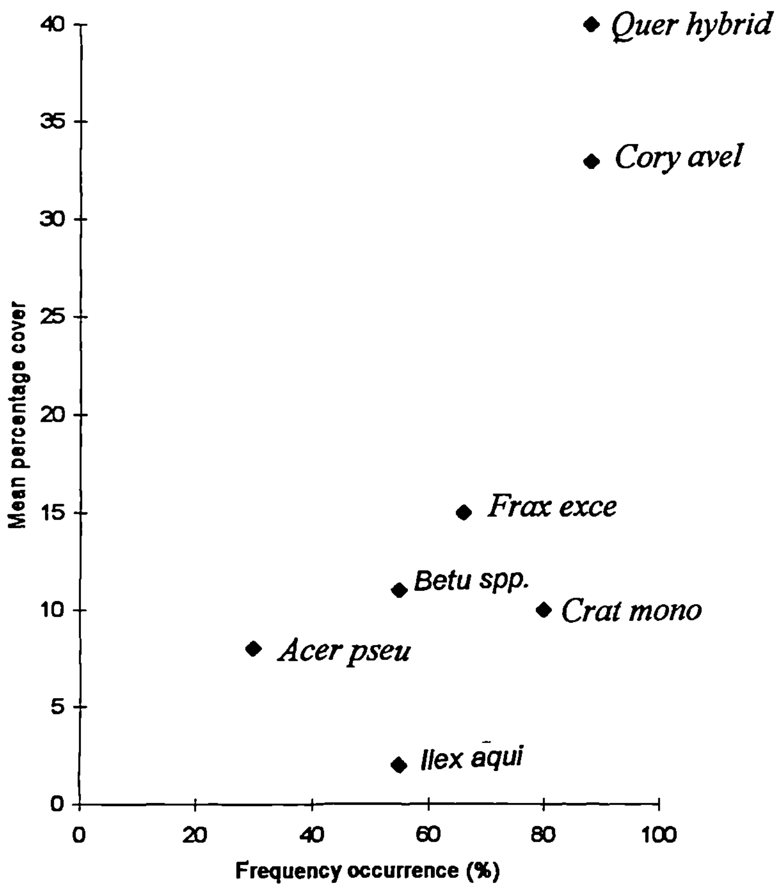
5.2.4 Ash-oak woodland

Synonymy:

NVC W8 - *Fraxinus-Acer campestre-Mercurialis perennis* stand

Ash-oak woodland with *Fraxinus excelsior, Quercus petraea x robur* and *Corylus avellana* as woody constants formed only a small portion of the forest and was confined to mainly linear habitats of strong base-rich soils along the Dowles valley, woodland edges abutting the River Severn, and the disused railway line. Oak dominated the canopy cover in these woods, accounting for 40.3% of the crown; ash contributed a further 15%. Approximately 10% of the forest crown was taken up with sycamore (FIGURE 5.2.4.1). The understorey was dominated by two species, Hazel - 33% cover, and hawthorn which accounted for 10% of cover. The remaining 22% of understorey was

FIGURE 5.2.4.1 Canopy and understory composition of ash/oak woodland



generally composed of sycamore, oak, ash and dogwood (values are calculated from ten NVC quadrats, each - 2500 m^2). The fieldlayer was generally species-rich and there was an abundance of *Geum urbanum, Lamiastrum galeobdolon, Hyacinthoides non-scripta, Geranium robertianum and Rubus fruticosus* agg.

5.2.5 Birch-mire woodland

Synonymy:

NVC W4 Betula-Molinia caerulea stand

This stand type occured in small patches, most often on spring flushes located on steep sides of gullies and valleys. The constant woody species throughout this woodland was *Betula pubescens*. The other common tree was *Salix cinerea* which rarely reached into the canopy but more often formed a tall understorey. Also in the shrub layer was both *Crataegus monogyna* and *Prunus spinosa*. Many of these wetland flushes were marked by the presence of a large yew tree.

The fieldlayer was a mixture of *Molinia caerulea and Juncus effusus* whose proportions varied from site to site. Some flushes consisted of pure stands of *Molinia* with little or nothing else growing. Other areas supported a mixture of *J.effusus* and several associated herbs including *Ranunculus flammula* and more occasionally, *Scutellaria minor and Dryopteris dilatata*. One or two of the stands in the forest supported thick mats of *Agrostis stolonifera* and *Hydrcotyle vulgaris*. Two particular forest flushes situated on the edge of Park Brook had a distinctive assemblage in which *Eriophorum latifolium* and *Molinia caerulea* were the two most abundant species. Other associated species included *Primula vulgaris, Valeriana dioica* and *Eupatorium cannabinum*.

5.3 SILVICULTURAL STANDS

Approximately 55-60% of the forest has been replanted since the introduction during the twentieth century of new silvicultural practices. Much of the oak has been grubbed out or heavily thinned and underplanted with more commercial species. The remaining oak has been managed as high forest mixed broadleaved woodland and covers 281 hectares of non semi-natural forest (near to 30% of Forestry Enterprise holdings). In addition to the underplanted oak a variety of commercial species have also been introduced into Wyre (TABLE 5.3.1). Traditional coupe boundaries have been abandoned in favour of a sub-compartment scheme which is based on species and age of stands and not on ownership. Within the main block of Wyre there were 38 compartments (FIGURE 5.3.1) which were further divided into 382 sub-compartments which had a mean area value of 3.71 hectares.

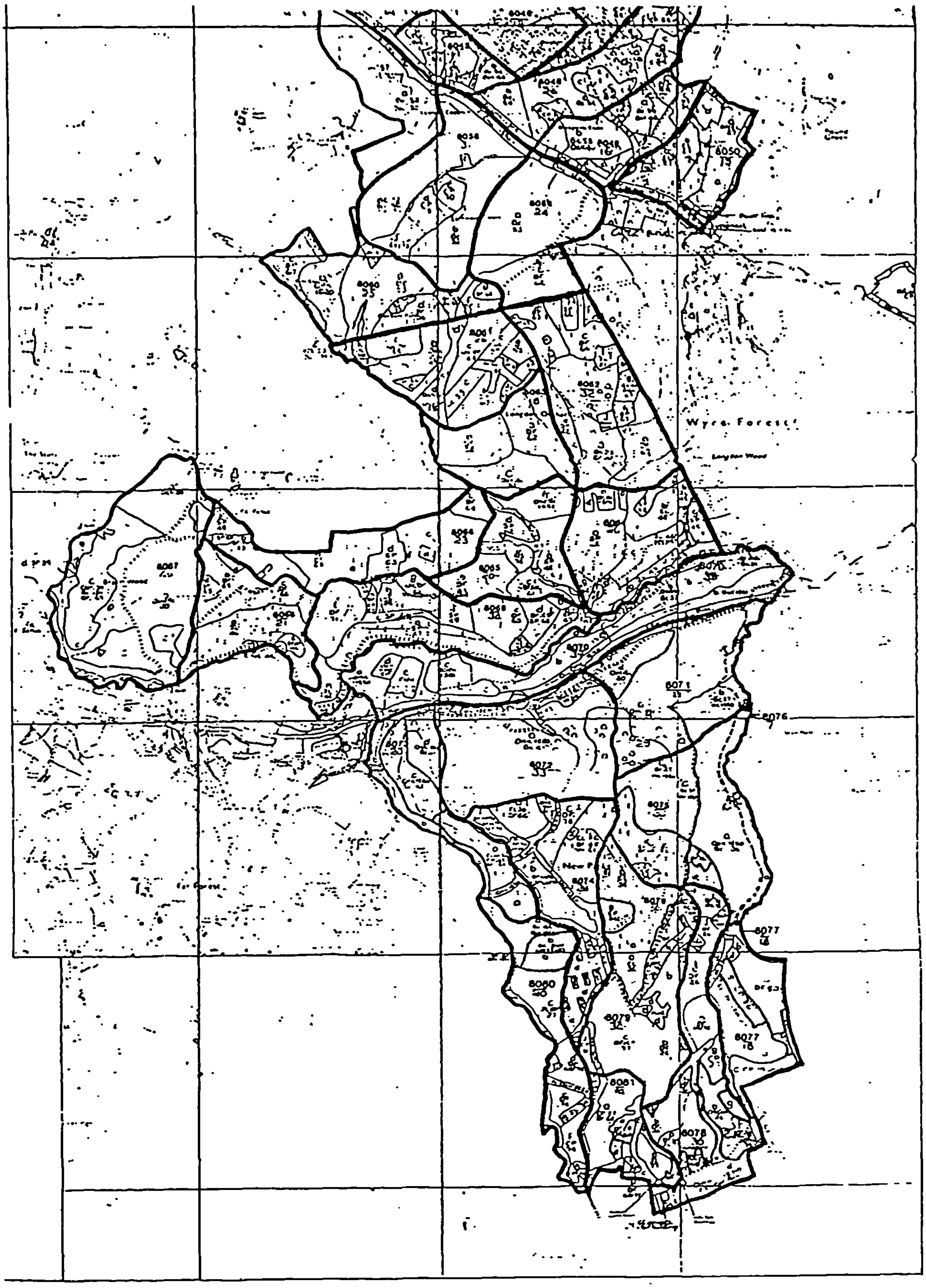
TABLE 5.3.1 Silvicultural plantations of Wyre Forest under the Forest Enterprise management.

(The values are calculated from the 1989 data base. Since this time there have been a number of minor changes which have included the removal of a portion of larch and the subsequent replanting of Corsican pine.)

Species	Tot.area (ha.)	% prop. of forest	Mean area of compt. (ha.)	Mean age of plots	Mean yield class
Oak	281.1	29.8	2.47	71	3.83
Beech	161.3	17.1	3.10	39	4.76
DF	140.6	14.9	1.90	27	10.65
Pine	126.3	13.4	1.42	28	11.22
Larch	97.9	10.4	3.55	42	8.00
NS	26	2.7	1.16	32	11.92
Wh	39.5	4.2	1.27	31	14.77
Lc	18.8	1.9	1.25	32	12.31
birch	18.0	1.9	1.2	35	1.22
Others	1.1	-	-	-	-
Unprod. Areas	47.5	-	-	-	-

KEY: DF = Douglas fir; NS = Norway spruce;
WH = western hemlock; LC = Lawson's cypress.

FIGURE 5.3.1 Forest Enterprise woodland compartments and subcompartments



Whilst silvicultural plantations were present elsewhere in the forest the majority of them were concentrated on state owned land (FIGURE 5.3.2). The plantations were compartmentalized into age groups although generally the conifer stands were much younger than the remaining oak woods (FIGURE 5.3.3). As many of the crop species were planted as mixtures it was more appropriate for the purpose of this thesis to divide the plantations into distinctive stand-types as follows:

- Oak underplanted with beech;
- Birch scrub woodland;
- Mixed broadleaved stands;
- Conifer/broadleaved mixed stand;
- Mixed conifer plantation;
- Light canopy conifer plantation - larch (Hybrid and Japanese), pine (Scots and Corsican); and
- Heavy canopy conifer plantation - Douglas fir, Norway Spruce, Lawson's Cypress, Western hemlock

Oak underplanted with beech

In 1930 beech was planted into old oak woodland first by cutting down the oak 'scrub' and then by planting beech whips at 2m spacing. Since then thinning of mature trees has been carried out by selecting for the best tree irrespective of species.

These mixed broadleaved plantations had a dense canopy cover with very little understory or fieldlayer (91% of the ground is bare and *Holcus mollis* was the most prominent species, accounting for 4% of the fieldlayer. Values were calculated from 30 quadrat samples recorded for the ISA study, 1989). The remainder of the cover was predominantly *Pteridium aquilinum, Rubus fruticosus* agg. *and Vaccinium myrtillus*. In the more heavily thinned plantations the ground vegetation was better established and supported *Rubus fruticosus* agg., *Pteridium aquilinum, Agrostis capillaris and Holcus mollis*. Large stands of *Hyacinthoides non-scripta* occurred in more localised areas throughout the stand-type. A noticeable feature of these woods was the frequent occurrence of *Taxus baccata,* although George (1987) stated that there were many more yew before the introduction of modern forestry practices. In the past *Convallaria majalis* was frequent in the field layer (George 1990), whereas today it is lost to these areas.

FIGURE 5.3.2 Silvicultural plantations on state-owned land, Wyre Forest.

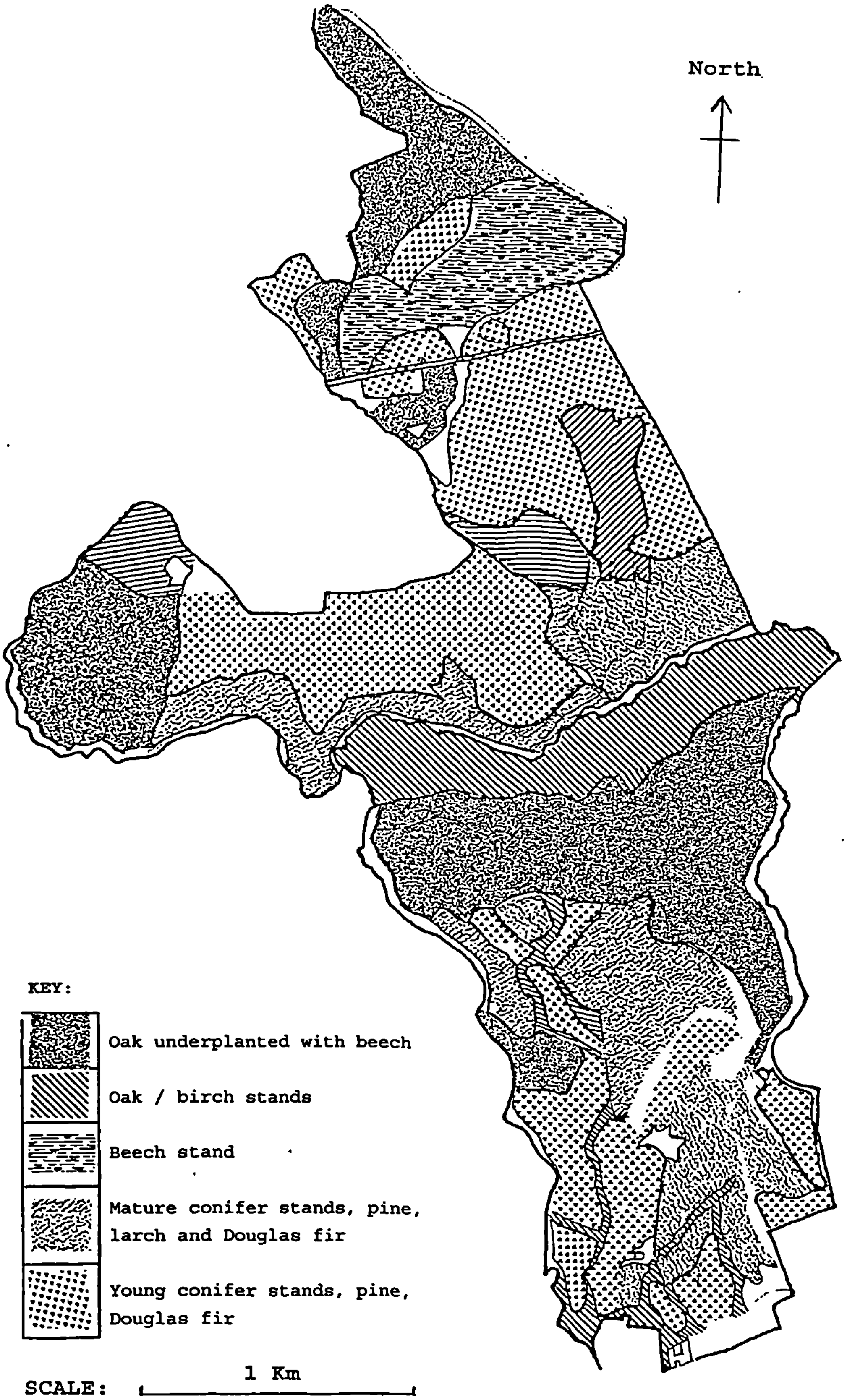
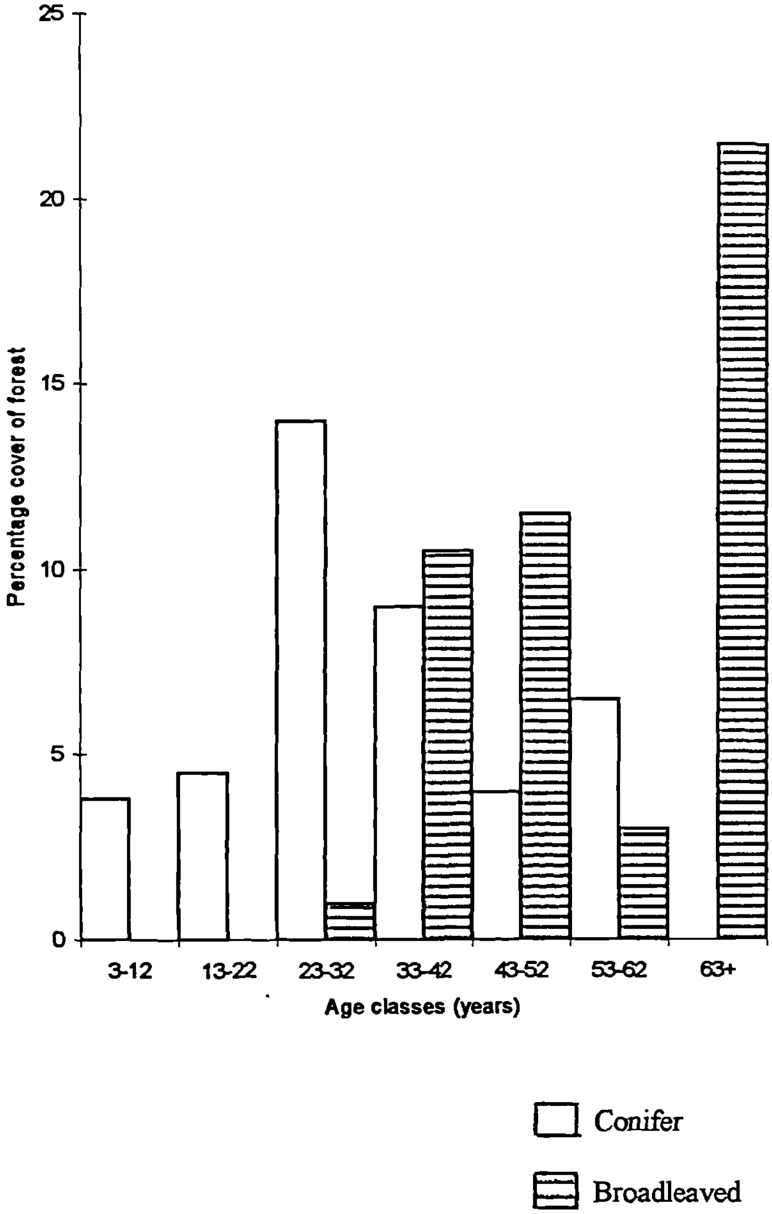


FIGURE 5.3.3 Age structure of conifer and broadleaved woodland on state-owned land, Wyre



Birch scrub woodland

Small stands of birch woodland occur in Wyre with the most important cluster found on land managed by Forestry Enterprise. Within the 942 hectares of state owned land there was approximately 18 hectares of birch dominated woodland (1.9 % of state-owned land, based on values calculated from Forest Enterprise data base). However, this does not take into account the numerous birch trees and saplings in both mature conifer and broadleaved stands, making it one of the most abundant species in the forest.

The two woody constants in birch scrub stands were *Betula pendula* and *Quercus petraea*. In amongst these trees but in lower numbers were *Betula pubescens, Crataegus monogyna, Sorbus aucuparia and Salix cineraea*. The field layer varied considerably according to the underlying geology. On the shale or clay a more calcicole community existed with a phytosociology akin to that of a moist oak-bramble-bracken stand type. Prominent species included *Deschampsia cespitosa, Dryopteris filix-mas, Agrostis capillaris, Primula vulgaris and Viola riviniana.*

On the dryer, lighter sandy soils a calcifuge community was evident with such species as *Deschampsia flexuosa, Galium saxatile, Vaccinium myrtillus and Polytrichum formosum.*

A feature of both types of birch woodland was the density of woody species throughout a stand; trees and shrubs combined numbered 2000-3000 per hectare.

Mixed broadleaved stands

A small proportion of the forest may be classified as mixed broadleaved stands. One such stand was situated close to the forestry car park and was a mixture of predominantly *Nothofagus obliqua/procera* with some remnant *Q.petraea* and *B.pendula.* The underlying field layer was almost exclusively *Pteridium* and *Holcus mollis*.

Further east in Cold Harbour Coppice, adjacent to the drive up to Bow Castle (SO 755 749) was a small stand of *Acer psudoplatanus* and *Q.petraea*. Recently efforts have been made by English Nature to clear the sycamore out of the wood. A rather more extensive stand of this species was to be found along the Dowles Brook just west of Rudgebridge (SO 727 762). Within this stand both *A.pseudoplatanus and Populus nigra* dominated the canopy. However, a wide range of other species also occurred in both canopy and understory including *Alnus glutinosa, Q.petraea x robur, Fraxinus excelsior, Crataegus monogyna, Corylus avellana and Salix cinerea*. The field layer vegetation was usually lush with much the same species composition as that found in alder-ash riparian woodland.

In other parts of main block Wyre stands of *P.nigra* had been cleared to help promote the conservation of wetland springs (SO 749 799). Rather more extensive stands of mixed broadleaved woodland were to be found in some of the outlying woodlands which formed part of Greater Wyre including Birchen Park (SO 7080), Hawkbatch (SO 7677), Ribbesford (SO 7872) and Shatterford (these sites will not be covered in the description as the outlying woodlands were not included in this research study).

Conifer plantations

The remaining four stand types listed earlier include all those areas of the forest which have largely been cleared of the traditional woodland and replanted with conifer either as pure single-aged stands; mixed conifer, or conifer/broadleaved woodland. Six principal species of conifer have been planted in pure or mixed stands, the earliest dating back to 1926. In the earlier years of afforestation Larix spp. was the principal tree to be planted. However, after its failure in the 1940s other species were selected. At present, *Pseudotsuga menziesii* is the most important component of the coniferised forest, and accounts for 34% (140.6 hectares) of all softwood grown on state-owned land. As for *Larix* spp. its percentage proportional value is presently 23% (97.9 hectares), a figure which continues to decline as mature stands are felled and the open ground replanted with pine or Douglas fir.

Throughout the coniferised plots many of the previously existing yew have been removed (George 1990) whilst birch scrub is periodically cleared out from pre-thicket stands. In the more mature wooded areas there is some return of birch scrub but this never amounts to more than a thin scattering of young whips as they too are removed or eventually shaded out by the evergreen canopy.

The pattern of change of vegetation over the 60 years of coniferisation has taken a predictable course in that the forest field layer has been gradually suppressed and often lost by the time the conifers have reached thicket stage. As the conifer stands have matured and undergone progressive thinning the field layer has re-established itself *(FIGURE 5.3.4). In both valley and plateaux* mature conifer plantations there is a high proportion of bare ground and a vegetation dominated by just a few species (FIGURE 5.3.5). In well established pine woods planted on originally densely covered heather sites (George 1987) the field layer has diminished and the proportion of bare ground has dramatically increased (58% of ground cover out of a sample of 30 quadrats). The heather has been replaced by a thin cover of *D.flexuosa and Holcus mollis*, approximately 10% in each case whilst another 5% has been taken up by *V.myrtillus and Pteridium aquilinum* (values taken from 30 quadrat samples). Fir and larch were observed growing on rather deeper soils often associated with the presence of a *Pteridium/Rubus/Holcus mollis* dominated assemblage of plants. These three species were particularly abundant in mature plantations (TABLE 5.3.2) where together they formed constants in the fieldlayer. Substantial tracts of thicket-stage conifer support vernal species such as *Hyacinthoides non-scripta, Viola riviniana, Anemone nemorosum and Primula vulgaris.* In contrast, these species are largely absent from the mature plantations (FIGURE 5.3.6). In their place grew a profusion of *Digitalis purpurea* particularly along old extraction tracks. It is possible that the strong presence of this species is an indication of the level of ground disturbance experienced during regular thinning programmes in post-thicket plantations.

FIGURE 5.3.4 Principal plant community-types for the silvicultural stands - Wyre

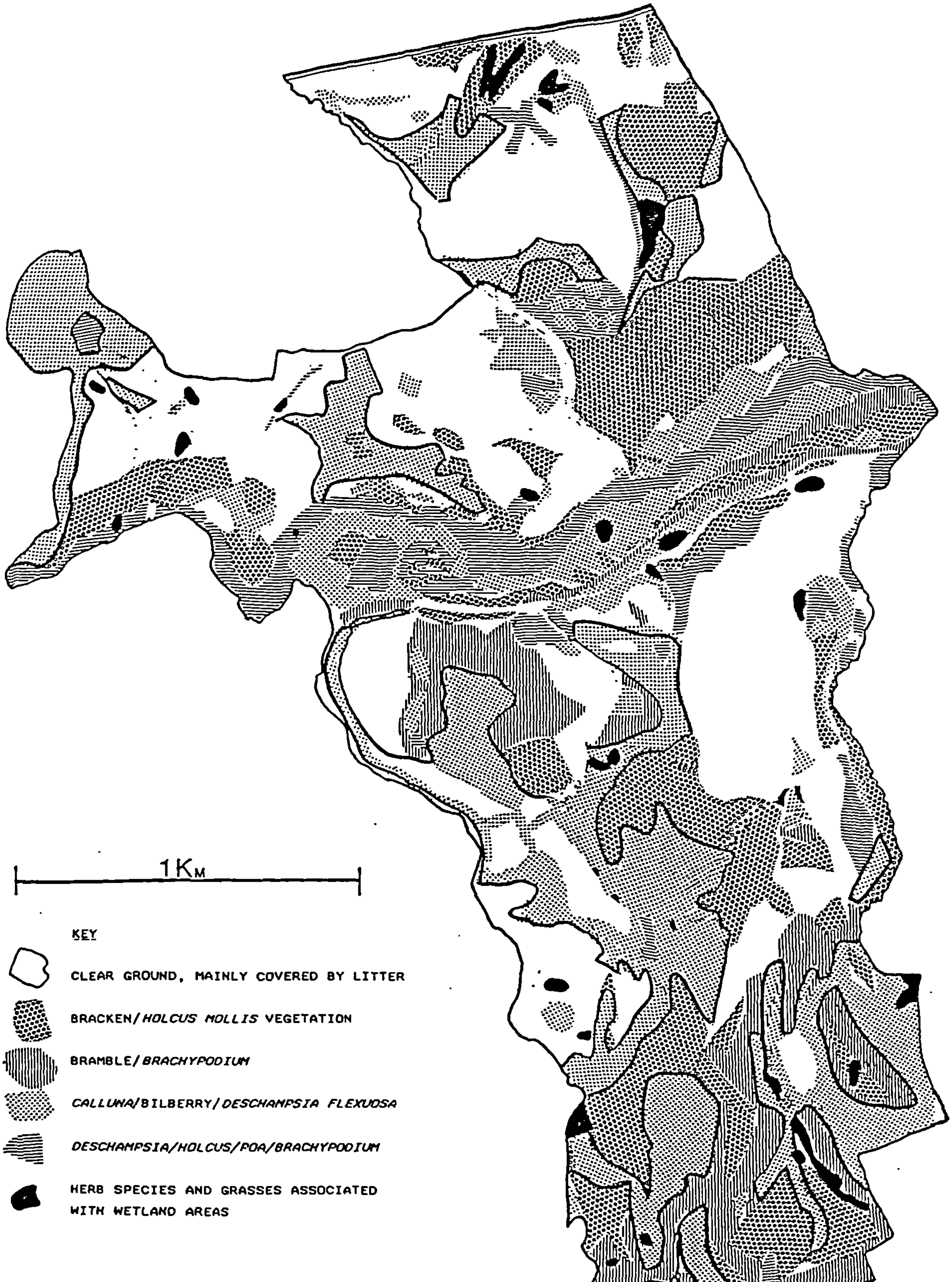


FIGURE 5.3.5 Principal plant species of plateaux & valley plantations, Wyre

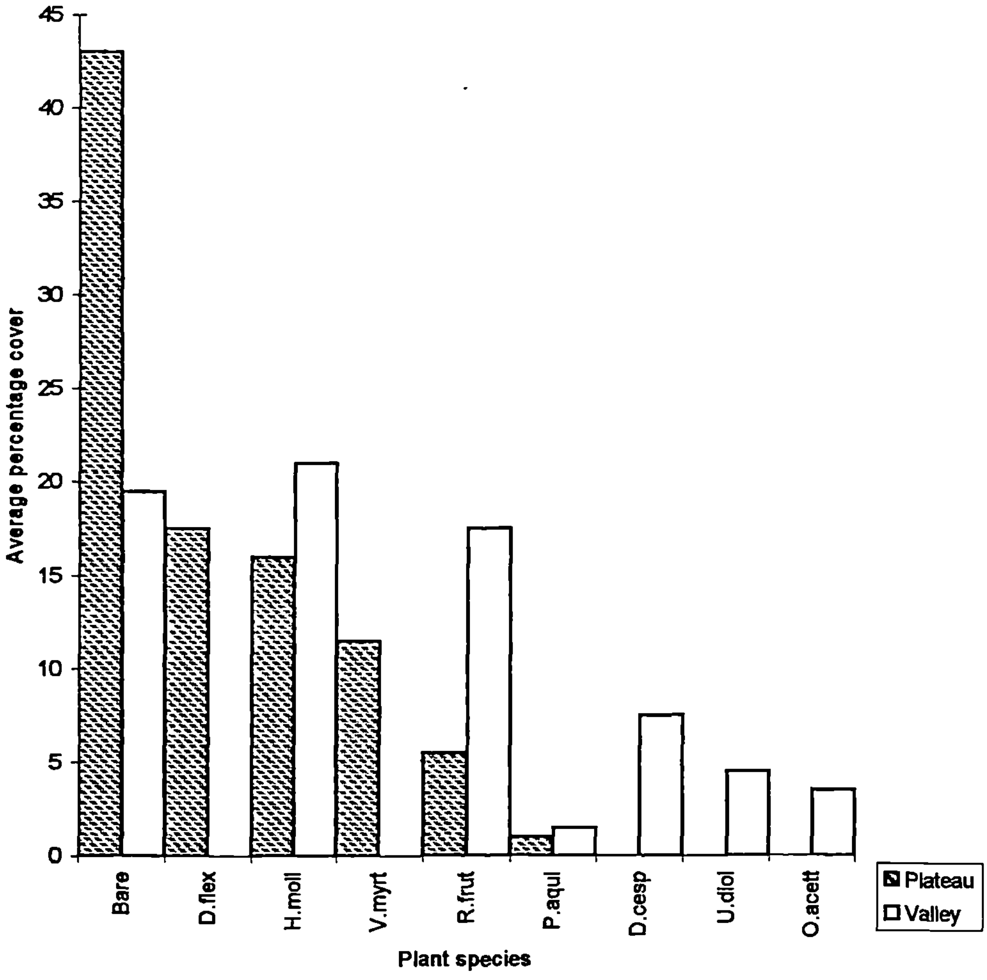


FIGURE 5.3.6 Main colonies of *Anemone nemorosa* & *Hyacinthoides non-scripta* in the plantations, Wyre

KEY:

Broadleaved woodland

Mature conifer plantation

Young conifer plantation (first rotation)

Main colonies of *Anemone nemorosa* & *Hyacinthoides non-scripta*

TABLE 5.3.2

	Douglas Fir plantations, planted 1926	
	Valley site 30 quadrat samples	Plateau site 30 quadrat samples
No. of vascular plant species	32	19
Bare ground	26% cover	22% cover
Holcus mollis	11% cover	4% cover
Rubus fruticosus	18% cover	24% cover
Pteridium aquilinum	3% cover	0
Sorensen's Index of similarity for communities	0.72	

5.4 ANCILLARY HABITATS

Throughout the forest a variety of other habitats contributed to the woodland ecosystem (FIGURE 5.4.1). There were numerous meadows, lawns, rides and glades as well as an extensive network of road verges which also *functioned as grassland corridors, linking up* many of the open areas. Other than grassland, wetland habitat was also an important feature in the forest ecosystem. Road drains, springlines, flushes and brooks formed a drainage system which eventually drained into the River Severn.

5.4.1 Grasslands

Within the state-owned section of the forest there were some 15.4 hectares (1.6% of the forest) of grassland including all the 9 deer lawns, rides and road verges (FIGURE 5.4.1.1). The verges had a mean width of 3.3 metres and the deer lawns ranged in area from 1000 m^2 to 10,000 m^2. The wide range of soil-types associated with the scattered dispersal of lawns and verges across the forest, together with the complex soil patterns, gave rise to a number of

FIGURE 5.4.1 Main grassland and wetland habitats of Wyre

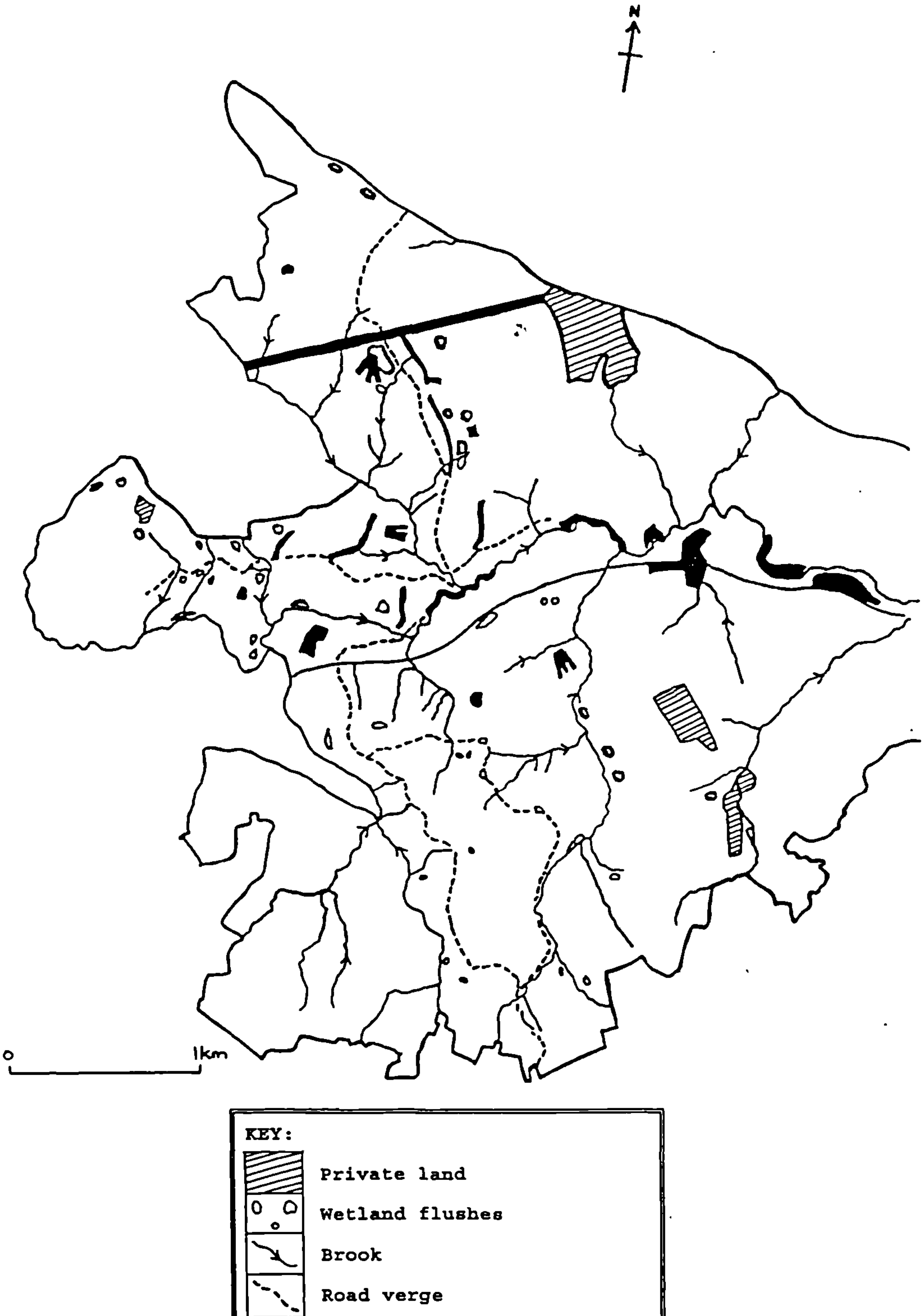
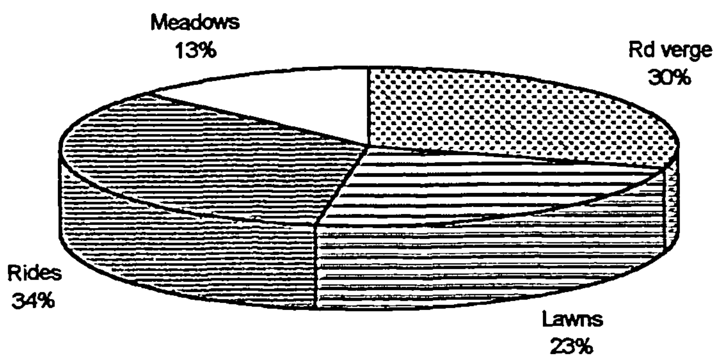


FIGURE 5.4.1.1 Proportions of the major grassland habitat - Forest Enterprise, Wyre



vegetation types ranging from heathy calcifuge plant associations on some of the lawns and rides to distinctly calcicole assemblages along the Elan Valley pipeline.

The grass species were varied on these sites although *Agrostis capillaris* was often the most abundant species. However, local variation occurred where there was a predominance of *Holcus mollis* on some of the lawns. The verges were less predictable in their composition and often had an abundance of *Dactylis glomeratus* mixed in with the *A.capillaris*. On the more waterlogged sites grass gave way to sedges e.g., *Carex flacca*.

Species of forb were well represented in Wyre and an estimated 94 species occurred on the areas of grassland within the state owned forest (FIGURE 5.4.1.2). However, there was considerable variation in species richness between the different grassland types, for instance, the mean number of herb species recorded per m^2 for the road verges was 8, whilst for the deer lawns it was 4.67 (these values are calculated from records taken from three hundred and eleven, 1 m^2, quadrats).

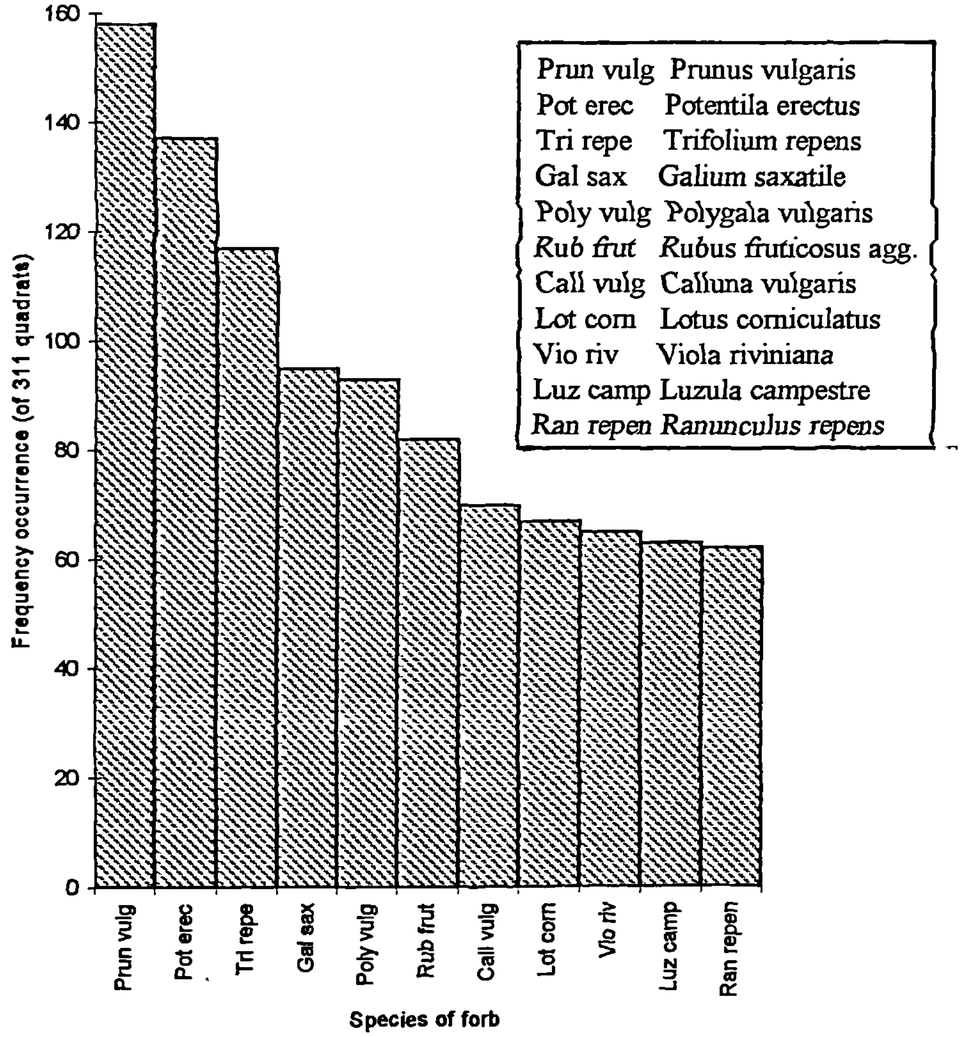
Deer lawns

In the 1970s a number of small glades were cut out of both conifer and broadleaved woodland to provide lawns for the large herd of Fallow deer. These areas were mown annually and several of the glades were regularly sprayed with a mixture of fertiliser and lime together with some seeding of clover. On these sites *Trifolium repens* was recorded as being widespread. However, there still existed a strong element of a more natural assemblage of herbs with the frequent occurrence of *Galium saxatile, Potentilla erecta, Veronica officinalis, and Pteridium aquilinum.*

Road verges

The road verges had elements of both calcifuge and calcicole plant assemblages, reflecting the patchwork of clay and sandy soil across the forest. The most frequently occurring species was *Prunella*

FIGURE 5.4.1.2 Principal forb species of forest grassland habitats, Forest Enterprise,Wyre



vulgaris (recorded in 70% of the 80 quadrats sampled), and other common herbs included *Potentilla erectas, Trifolium repens, Rubus fruticosus, Trifolium campestre, Fragaria vesca, Euphrasia* spp., *Ranunculus repens, Tussilago farfara, Lotus corniculatus, Polygala vulgaris and Viola riviniana.*

Traditional hay meadows.

The traditional meadows date back to the 17th century and were confined to the Dowles valley. In the past they were grazed by livestock and in one or two cases planted up with orchard trees, apple and damson. In recent years English Nature have reintroduced traditional forms of management which involves hay cutting in July-August and grazing of cattle and sheep through to the winter period. The traditionally managed grasslands were botanically rich in species, in particular the damp meadows. Some of the species associated with these meadows included *Stachys officinalis, Galium verum, Filipendula ulmaria, Ophioglossum vulgatum, Lychnis flos-cuculi, Achillea ptarmica, Pulicaria dysenterica, Scutellaria galericulata and Ajuga reptans*. On drier ground species such as *Polygala vulgaris, Ranunculus acris, Rhinanthus minor*, and *Prunella vulgaris* thrived. Some of the drier meadows supported sizeable populations of *Primula vulgaris, P.veris, P.veris x vulgaris, Lotus corniculatus,* and *Ophioglossum vulgatum*.

5.4.2 Wetlands

Wyre Forest forms an important watershed in the local region and the underlying geology lends itself to the formation of numerous springs. A number of these springs had their issues directly above fault lines where porous rock formed an unconformity with the impervious substratum and consequently water welled up to the surface. Some of these springs fed into gullies and contributed to the formation of brooks, whilst others occurred only as soaks or catchments with no apparent outlet. On state owned land all the CAT. 1A (large, graveled extraction roads) roads used for timber extraction were bordered either side by ditches and drains which took water away from the roads and fed it into the streams.

Base-rich flushes

Except for five sites all of the wetlands on state-owned land were of fen-type with a soil pH (4.5 - 6.5) higher than that recorded for the rest of the forest. The sites were typically waterlogged all year round but as most of them occurred on slopes the water was creeping. In nearly all cases the plant community was diverse with a mean density of 10 species per m^2 (calculated from data recorded from 30 quadrat samples). The most widespread herb species was *Lysimachia nemorum* (recorded in 66% of the 30 quadrats sampled), although throughout its distribution it formed only a sparse cover in the field layer. Four species: *Juncus effusus; Carex flacca; Juncus articulatus* and *Mentha aquatica* were widespread and occurred in relatively high abundance (5% for *M.aquatica* to 11% proportion of the ground cover for *J.effusus*. Values calculated from 30 quadrat samples). Other species, including *Agrostis stolonifera, Ranunculus flammula, Carex remota* and *Galium palustre* occured at much lower abundance across these wetland sites. Some sites supported dense stands of a particular species. For instance, one or two wetland sites had an abundance of *Hydrocotyle vulgaris, Carex pendula, Carex nigra or Filipendula ulmaria.* Two vegetation types were recognizable in Wyre: *Juncus* - moss dominated flushes, and *Carex*- herb-rich sites. On particularly large wetland soaks (the Great Bog, SO 747764; Longdon Orchard, SO 743776, SO 747772) both stand-types were often present.

Juncus - moss stand

In this particular stand type *Juncus articulatus*, and to a lesser extent *Juncus effusus,* formed a dense cover in amongst deep moss beds. Some of these flushes supported little else whilst others included the following species, *Equisetum palustre, Mentha aquatica, Ranunculus flammula, Valeriana dioica, Dryopteris dilatata, Athyrium filix-femina, Lychnis flos-cuculi, and Dactylorhiza fuchsii.*

Carex - herb-rich stand

This wetland type was characteristically more diverse than the previous one and indeed of all wetland habitats. Often extensive beds of *Carex flacca* covered the ground with smaller patches of *Carex demmisa* and *Carex pendula*. In a few cases *Carex pulicharis* was also present. A wide variety of herbs including *Filipendula ulmaria, Primular vulgaris, Mentha aquatica, Pulicaria dysenterica, Aquilegia vulgaris, Lysimachia nemorosa, Lotus uliginosus, Potentilla reptans, Cardamine pratensis, Eupatorium cannabinum, and Scutellaria minor* were recorded throughout these sedge beds.

In both stand-types shrubs such as *Viburnum opulus, Rosa canina, Frangula alnus, Prunus spinosa* and, rarely, *Ligustrum vulgare,* lined the outflows from these sites.

Base-poor flushes

Acid bogs were few and far between in Wyre. In most cases they were situated on fairly level ground either on plateaux or on the edges of a gully. The pH value of the soil was between 3.5 and 4 and the soil was more often than not covered in a dense peaty humus. The plant community was quite distinct from that of the fens. Sorensen's Coefficient of Community indicated only a 0.16 similarity between acid bogs and fens. On sites with some water flow and a higher pH value, *Molinea caerulea* often dominated the vegetation. There were very few other species although *Juncus effusus* and *Scutularia minor* was sporadic amongst the grass. The small catchments or soaks which were often little more than shallow depressions (prone to drying out in summer) supported *Sphagnum* spp., *Juncus bulbosus, Agrostis stolonifera* and *Carex nigra* (possibly var. juncea).

Open water

Nearly all open water habitat in Wyre Forest was man-made. Some of the pools had evolved subsequent to quarrying activity (quarry pool SO 740788; Bore hole SO 747751), whilst others had been constructed for wildlife reasons. There were marked differences between quarry by trees and consequently supported little plant life. Also they all had a very thick layer of leaf litter and organic sediment at the bottom, in one or two cases exceeding a metre in depth. These ponds were often, despite the poor plantlife, rich breeding grounds for palmate newts, dragonflies, caddis flies, and other invertebrates including diving beetles and water boatmen.

The "habitat" pools (the three most obvious are the experimental pool SO 746765; Longdon orchard pool, SO 743775; and the Parks pool, SO 742751) in contrast, were open and generally free of tree cover. These sites had a greater abundance of plants including several introduced species. Some of the plants growing in the emergent and submergent vegetation included *Potamogeton natans, Eleocharis palustris, Juncus articulatus, Juncus bufonius, Sparganium erectum, Lemna minor, Elodea canadensis* and *Nymphoides peltata*. In some years there was an algal bloom which supressed some of the higher plant growth.

5.5 SUMMARY

Wyre Forest is an extensive area of predominantly stored oak woodland with an abundance of birch, holly and yew. A number of species feature prominently in the field layer including *Holcus mollis, Lonicera periclymenum, Pteridium aquilinum, Rubus fruticosus* agg., *Teucrium scorodonia* and *Viola riviniana*. It is possible to distinguish several vegetation types, the two broadest categories being plateaux and valley woodland. The former type is mainly an oak-dominant calcifuge community which comprises of two guilds: *Deschampsia flexuosa-Vaccinium myrtillus-Calluna vulgaris*; and *Rubus fruticosus* agg.-*Pteridium aquilinum-Holcus mollis*. The principal valley-woodland community comprises of two stand-types which are united by the widespread prevalence and abundance of *Quercus* spp., *Corylus avellana, R.fruticosus* and *V.riviniana*. The two woodland-types are distinguished as wet alder-oak woodland and dry ash-oak stands. The former is typical riparian woodland characterised by the abundance of *Alnus glutinosus, Corylus avellana, Allium ursinum, Carex pendula* and *Lamiastrum galeobdolon*. The ash-oak woodland occurs on drier base-rich valley sites with a central distribution along the disused railway line. This stand is distinguished by the presence of *Acer pseudoplatanus, Corylus avellana, Crataegus monogyna, Fraxinus excelsior, Geum urbanum* and *Viola riviniana*.

Past and present management has a significant impact on the woody composition and structure of the forest. Additionally, the grazing impact of deer changes the competitive balance of the plant communities in favor of such species as *Pteridium aquilinum, Teucrium scorodonia* and *Viola riviniana*.

"scattered throughout the bracken - bramble vegetation were concentrations of *Melica uniflora, Euphorbia amygdaloides* and *Viola riviniana*. These three species together marked the location of old traditional charcoal hearth sites where the underlying soil appeared to be carbonized, and contained large nuggets of charcoal."

C H A P T E R 6

A VEGETATION ANALYSIS OF WYRE FOREST

6.1 INTRODUCTION

In the last seventy years several vegetation studies have been carried out in Wyre of which the most noteworthy contributions have been made by Salisbury (1925) and Fincher (1976). The primary aim of these studies was to produce a description and classification of the different forest stand-types. The work by Fincher (1976) incorporated Peterken's classification system into a PHASE II Woodland survey of the semi-natural stands. However, this study was incomplete as it excluded substantial areas of woodland that was planted rather than semi-natural. Until now there has been no attempt to complete an extensive vegetation survey of the forest using a more objective method of recording combined with a standardised system of classification.

The vegetation analysis reported in this thesis centred around two very separate studies. In the first case the field layer vegetation in eight different plantations situated in both valley and plateau areas were sampled by applying a large number of small systematically spaced quadrats (see Chapter 2). The absence of indigenous woody species made it impractical to survey the plantations using the NVC-style method. The sampling strategy covered both conifer and mixed broadleaved woodland, and was confined to areas of state-owned forest. The analysis of the data was by Indicator Species Analysis (Hill et al. 1975). In the second instance an equally large study was carried out throughout all areas of semi-natural woodland in Wyre using the National Vegetation Classification system of surveying (Rodwell 1991), (see chapter 2). The data was analysed using TWINSPAN.

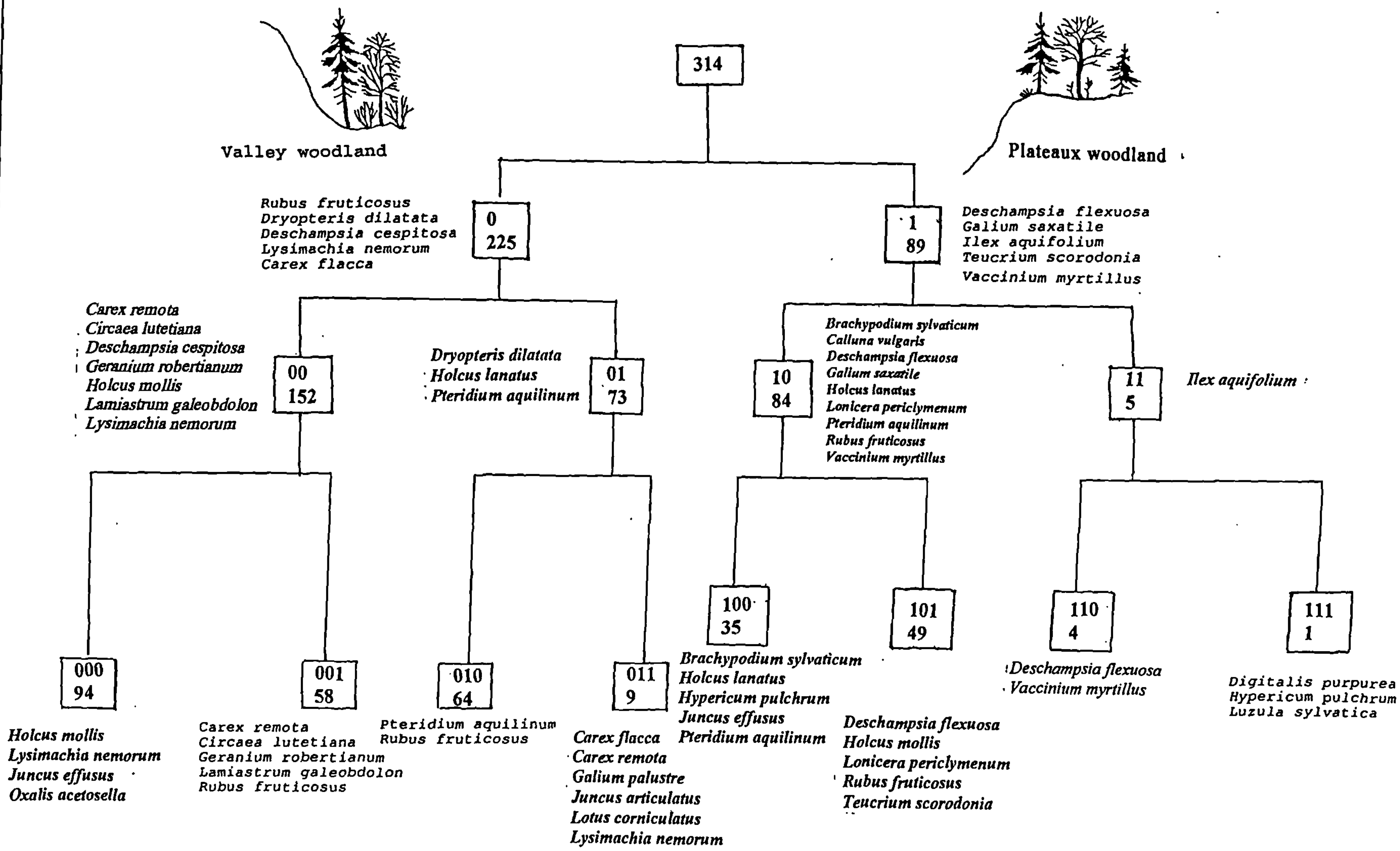
6.2 THE 1 M^2 QUADRAT SURVEY OF THE FIELDLAYER VEGETATION

The first division of the ISA was not between conifer and broadleaf woodland but rather identified two principal landscape vegetation-types (FIGURE 6.2.1). The cluster of samples in group 1 were situated on plateaux whilst those in group 0 were either on hill slopes or located in the valleys. This broad distinction in landform vegetation (FIGURE 6.2.2) is in line with Salisbury's (1925) findings and, more specifically, with ISA of the Seckley Ravine described by Packham and Willis (1976). The difference in soil pH between Group 1 and Group 0 was apparent with more extreme soil conditions present on the wetland flushes - Group 0001 (FIGURE 6.2.3).

6.2.1 Group 1 series - calcifuge community

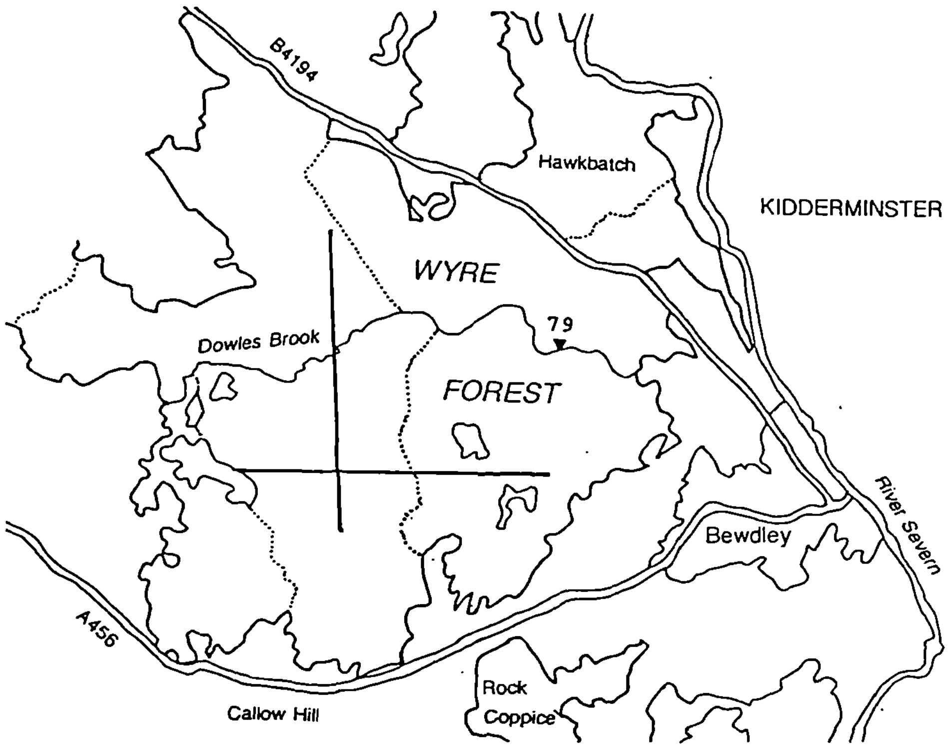
Group 1 was composed of samples primarily from the plateaux sites: i.e. the Larch plantation (8068 a); the singled oak stand (8067 a); and the Scots pine plantation (8064 a). The indicator species for this group were *Deschampsia flexuosa, Vaccinium myrtillus, Galium saxatile, Ilex aquifolium* and *Teucrium scorodonia* (TABLE 6.2.1.1). These five species are all indicators of infertile, undisturbed ground and apart from *T.scorodonia* and *Ilex aquifolium* are strongly associated with base-poor soils (Grime et al. 1988). They are typical representatives of the calcifuge plant community in Wyre Forest. Another distinctive species which was often associated with this community included *Calluna vulgaris*. A further division of Group 10 made a distinction between a large number of samples from the pine and oak stands (Group 100), and a cluster of quadrat samples from the larch and oak stands (Group 101). The preferential species (Fig. 6.2.1) for Group 100 were *Anemone nemorosa, Brachypodium sylvaticum, Deschampsia cespitosa, Hypericum pulchrum, Juncus effusus, Luzula sylvatica, Oxalis acetosella* and *Viola riviniana*. A number of the plants within Group 100 are indicators of a species-poor assemblage; moist habitats; and sparse or patchy vegetation cover (Grime et al. 1988), conditions which prevailed in parts of both the oak and pine plantation. The final decisive separation of the pinewood and oak stand samples occurred at the next level with the former pine plantation represented in Group 1001 and the remaining oakwood quadrats located in Group 1000. The pinewood shared certain community characteristics with the NVC woodland - W11 *Quercus petraea-Betula pubescens-Oxalis acetosella*. The results of the ISA also made a distinction between the larch (1010) and oak (1011) stands (FIGURE.6.2.1.1).

FIGURE 6.2.1 ISA classification of the 314 , 1m², , quadrat samples taken from eight plantations



(Species listed are indicator species)

FIGURE 6.2.2 Plateaux and valley formations, Wyre Forest ɔrest



Position of the topographical transects

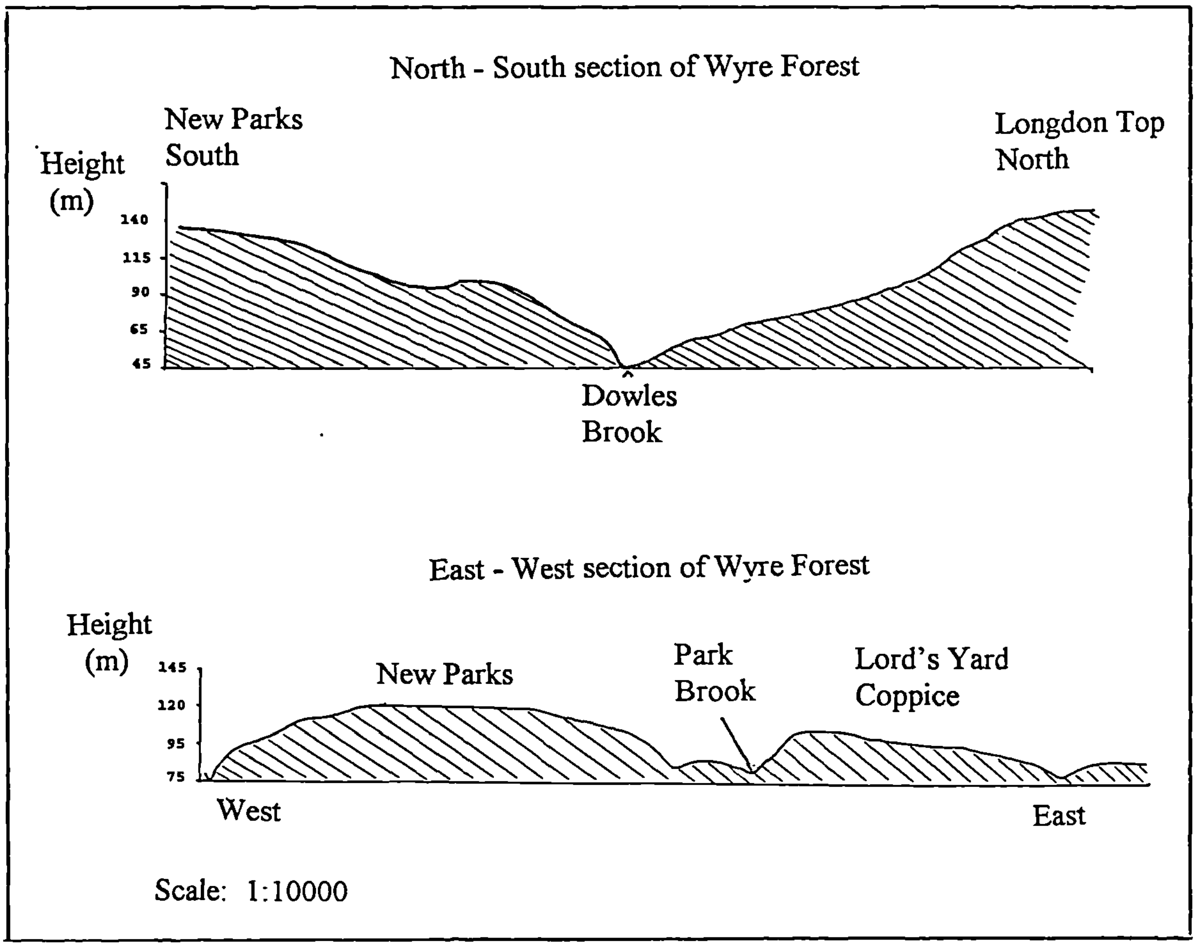


FIGURE 6.2.3 Mean pH values for five ISA Groups, Wyre Forest (vertical bars represent 95% confidence limits)

(Polythetic Groups represent the main stands and habitats surveyed)

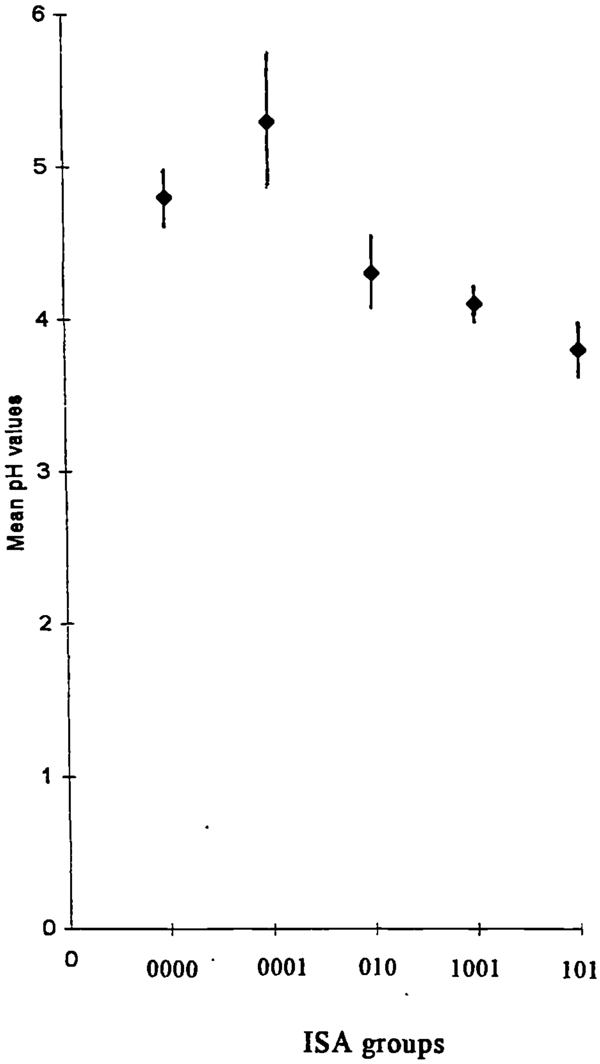
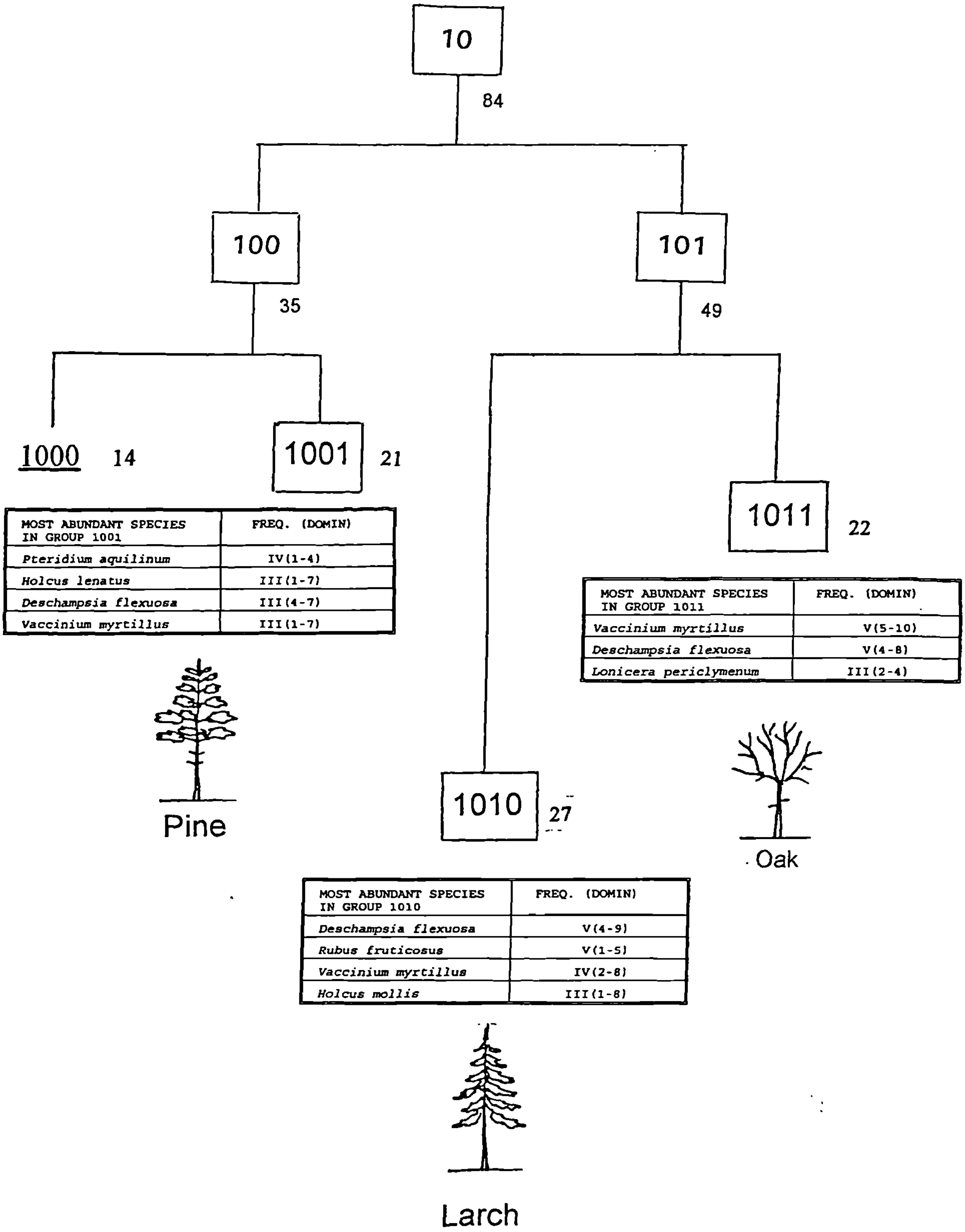


TABLE 6.2.1.1 Floristic table for the three plateau plantations

Species	*Forest plantations* 8067a (oak)	8068a (larch)	8064 (pine)	NVC W16
Vaccinium myrtillus	*V(5-10)*	*IV(2-8)*	*III(1-7)*	II
Deschampsia flexuosa	*V(4-8)*	*V(4-9)*	*III(4-7)*	V
Rubus fruticosus agg.	*I(4)*	*V(1-5)*	*II(1-5)*	II
Lonicera periclymenum	*III(2-4)*	*I(1-4)*	*I(1-2)*	I
Ilex aquifolium	*I(3)*	*I(1-2)*	*I(1)*	II
Betula pendula	*I(3)*	*I(1-2)*	*I(2)*	IV
Galium saxatile		*II(1-5)*	*II(1-2)*	I
Holcus mollis	*II(3-5)*	*III(1-8)*	-	I
Holcus lanatus	*I(3-8)*	-	*III(1-7)*	I
Pteridium aquilinum	-	*I(1)*	*IV(1-4)*	IV
Teucrium scorodonia	*I(5)*	*II(1-4)*	-	I
Calluna vulgaris	*I(3-7)*	*I(1-5)*	-	II
Potentilla erecta	-	*I(1-2)*	*I(1)*	I
Oxalis acetosella	-	-	*II(1-5)*	I
Viola riviniana	-	-	*II(1-4)*	
Brachypodium sylvaticum	-	-	*I(2-9)*	
Deschampsia cespitosa	-	-	*I(1-7)*	I
Juncus bufonius		*I(4)*	-	
Mnium hornum		*I(2-4)*	- -	I
Polytrichum formosum		*I(2-4)*	-	
Hypericum pulchrum	-	-	*I(1-4)*	
Pinus sylvestris	-	-	*I(4)*	I
Polygala serpyllifolia	-	*I(4)*	-	
Stachys sylvatica	-	-	*I(4)*	
Veronica officinalis	-		*I(4)*	
Carex sylvatica	-		*I(1-2)*	
Dryopteris dilatata	-	-	*I(1-2)*	
Larix decidua	-	*I(1-2)*		
Luzula sylvatica	-	-	*I(1-2)*	I
Anemone nemorosa	-	-	*I(1)*	
Juncus effusus	-	-	*I(1)*	
Quercus petraea	-		*I(1)*	I
Number of samples	30	30	30	
Number of spp./sample	4(2-5)	5(2-8)	5(1-8)	
Tree cover (%)	80(75-90)	65(60-75)	85(70-90)	
Shrub cover (%)	10(5-15)	2(0-5)	2(0-5)	
Field layer (%)	80(60-100)	70(60-80)	40(10-70)	

(The species shown in bold and underlined are the indicator species for Group 1. Roman numerals indicate frequency and values in brackets represent the DOMIN range for each species). Plant species are in order of abundance and frequency.

FIGURE 6.2.1.1 Floristic tables for the ISA polythetic groups - 1001, 1010 & 1011.



MOST ABUNDANT SPECIES IN GROUP 1001	FREQ. (DOMIN)
Pteridium aquilinum	IV(1-4)
Holcus lenatus	III(1-7)
Deschampsia flexuosa	III(4-7)
Vaccinium myrtillus	III(1-7)

MOST ABUNDANT SPECIES IN GROUP 1011	FREQ. (DOMIN)
Vaccinium myrtillus	V(5-10)
Deschampsia flexuosa	V(4-8)
Lonicera periclymenum	III(2-4)

MOST ABUNDANT SPECIES IN GROUP 1010	FREQ. (DOMIN)
Deschampsia flexuosa	V(4-9)
Rubus fruticosus	V(1-5)
Vaccinium myrtillus	IV(2-8)
Holcus mollis	III(1-8)

Both larch and oak woods had a characteristically impoverished plant community dominated by *Deschampsia flexuosa* and *Vaccinium myrtillus*. However, there were some differences between the two stands including the absence of *Galium saxatile, Potentilla erecta* and *Juncus bufonius* from the oak woodland, and the greater abundance of *Rubus fruticosus* in the larch plantation. More generally, both plantations had a community composition similar to the one described for the NVC W16 *Quercus* spp.-*Betula* spp.-*Deschampsia flexuosa* stand type (TABLE 6.2.1.1).

6.2.2 Group 0 series - less acidophilous communities of damper sites

Group 0 community was much more complex than Group 1, consisting of an amalgamation of quadrat samples from a deeply-shaded beech wood; a hill-slope conifer plantation; a deep ravine; wetland flushes; and valley woodlands. Consequently, indicator species for Group 0 were a combination of primarily base-rich loving plants and those typical of wetlands. The second level of division in the analysis distinguished between the beech plantation and the dry Corsican pine gully samples (Group 01) on the one hand, and the remaining damp-loving communities (Group 00) on the other. Both pine and beech plantations had deeply-shaded stands on more freely draining soils. The species composition of group 01 included the following preferential plants, *Dryopteris dilatata, Holcus mollis* and *Pteridium aquilinum* (TABLE 6.2.2.1). All three species are common in areas of Wyre which have experienced a moderate amount of disturbance or modification including planting of commercial trees. Group 00 was a broad cluster of samples from the Seckley ravine; two riparian woodland stands - one semi-natural and the other coniferous; and seven wetland sites. The preferential species in this group were either moisture-loving plants or species more commonly found on base-rich soils. They included *Carex remota, Circaea lutetiana, Deschampsia cespitosa, Geranium robertianum, Lamiastrum galeobdolon* and *Lysimachia nemorum*.

TABLE 6.2.2.1 Floristic table of the key species for both the beech and valley-pine plantations

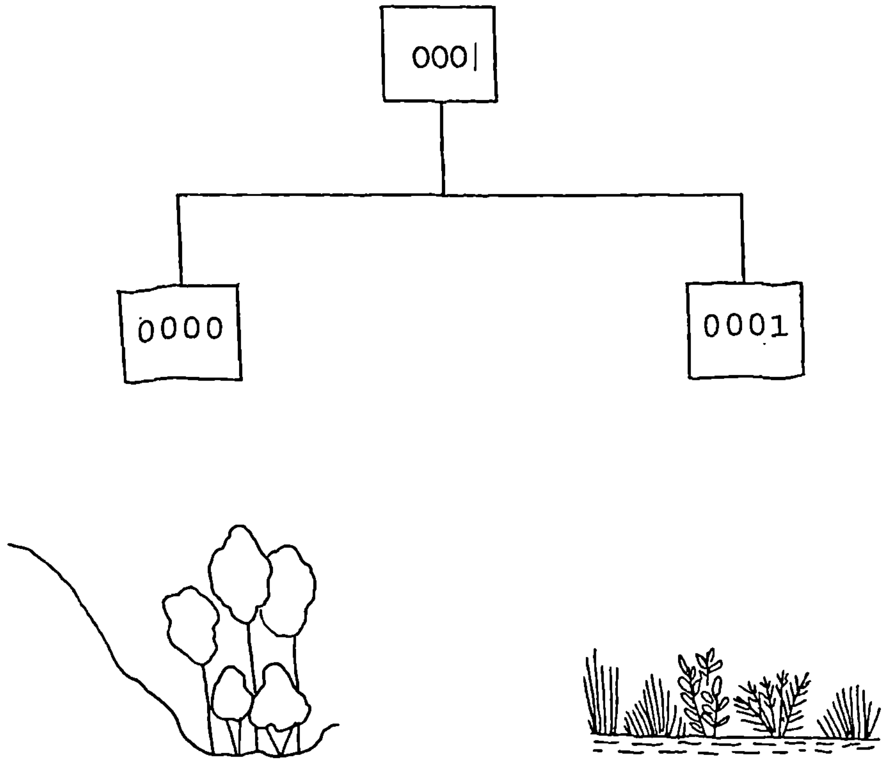
SPECIES	BEECH	VALLEY - PINE	GROUP 01 (combined beech/pine)
Rubus fruticosus agg.	I (2-4)	V (1-8)	IV (1-8)
Holcus lanatus	I (1-4)	V (1-10)	III (1-10)
Oxalis acetosella	-	IV (1-6)	II (1-6)
Viola riviniana	I (2)	II (1-4)	II (1-4)
Pteridium aquilinum	II (2)	I (1-4)	II (1-4)
Dryopteris dilatata	I (1-1)	III (1-4)	II (1-4)
Melica uniflora	-	II (1-10)	I (1-10)

Group 00 subdivided into Group 001 - valley Douglas fir and Seckley ravine; and Group 000 - riparian oak, Seckley ravine and wetlands. In the former group the preferential species included *Brachypodium sylvaticum, Carex remota, Circaea lutetiana, Dryopteris filix-mas, Epilobium montanum, Galium aparine, Geranium robertianum, Lamiastrum galeobdolon* and *Urtica dioica*. These species are more typical of moist rather than waterlogged soils, and several of them are nutrient-rich indicators within calcicolous communities (Grime et al. 1988). The preferential species for Group 000, which included *Anthoxanthum odoratum, Holcus mollis, Juncus effusus, Lysimachia nemorum* and *Oxalis acetosella*, have in common a tendency to colonise damp to wet, rather less nutrient-rich sites (Grime et al. 1988). Finally, Group 000 later split into Group 0001, wetland sites; and Group 0000, valley woodlands, (FIGURE 6.2.2.1). The former group was identified by the following species, *Carex flacca, C.remota, Equisetum palustre, Juncus effusus, Lysimachia nemorum, Mentha aquatica* and *Ranunculus flammula*. The species present in Group 0000 were mostly typical of cool, shady woodland and included the following preferential species: *Anthoxanthum odoratum, Deschampsia cespitosa, Holcus mollis, Oxalis acetosella, Rubus fruticosus* agg., and *Viola riviniana*.

In summary, the ISA analysis at the first division distinguished between samples taken from plateaux areas and those of the valleys and slopes and this recognition of two primary vegetation stands conforms with the findings of Salisbury (1925). The principal components contributing to this split are most obviously the pH status and moisture level of the soil, and to a less obvious extent the degree of shade and disturbance. Several of the key indicator species in the analysis highlighted these factors. The ecological amplitude of two species, *Juncus effusus,* and *Holcus lanatus* in Group 100 (pine and oak stands) include low shade tolerance and an ability to cope with a moderate level of disturbance. Furthermore both species are associated with moderately productive vegetation (Grime et al. 1988) Also *H.lanatus* and *P.aquilinum* (another key indicator species for this group) are often found in woodland which has undergone silvicultural change (Grime et al. 1988, Rodwell 1991). In contrast *Deschampsia flexuosa* and *Vaccinium myrtillus,* representative of Group 1011, are both centred on unproductive vegetation (Grime et al 1988), and favour undisturbed habitats which would conform with the low level of management experienced by the semi-natural oak woodland.

The species preferential to Group 0 cover a more complex pattern of environmental variables although those species identified in the analysis also serve as good indicators of pH status, shade tolerance and productivity. For instance, *Dryopteris dilatata* and *Oxalis acetosella* (Group 01 - beech and gully pine stands) show a strong ordination towards a tolerance of shade (Grime et al. 1988) Similarly, both plants are often found on acidic soils in moderate to unproductive vegetation with no particular preference for broadleaved woodland (Grime et al. 1988). The presence of *Circaea lutetiana, Lamiastrum galeobdolon* and *Dryopteris filix-mas* in the wooded valleys and depicted in Group 001 of the ISA suggest a combination of moderate productivity, deep shade, low disturbance and fairly high moisture (Grime et al. 1988). In the case of *D.filix-mas* and *L.galeobdolon* there is a high tolerance of leaf litter, a feature typical of the heavily shaded valley and ravine woods.

FIGURE 6.2.2.1 Floristic tables for the ISA polythetic groups - 0000 & 0001.



Floristic table of the most abundant species

SPECIES	ISA GROUP 0000 Freq. (DOMIN)	ISA GROUP 0001 Freq. (DOMIN)
Quercus spp.	IV(1-5)	-
Rubus fruticosus	III(2-6)	I(1-2)
Viola riviniana	III(1-5)	I(1-3)
Lysimachia nemorum	I(1-5)	IV(2-4)
Juncus effusus	I(1-2)	III(1-7)
Holcus mollis	IV(2-9)	I(4)
Deschampsia cespitosa	IV(4-7)	I(3-4)
Ranunculus flamulla	-	III(4-8)
Carex flacca	-	II(2-9)

6.3 NATIONAL VEGETATION CLASSIFICATION (NVC) SURVEY

6.3.1 Selecting homogeneous stand-types

A range of vegetation types were identified within the semi-natural woodlands of Wyre Forest using the criteria devised for selecting homogeneous stands in the NVC (Rodwell 1991). This method is based on recording species which are both abundant and constant (expected to occur in at least four quadrats out of five sampled) within a particular stand. (Causton 1988). Vegetation types were distinguished on the basis of a change in the representativeness of species constants. On this basis several communities and smaller guilds were identified. In its broadest definition the homogeneous stand-types were similar to those described in Chapter 5. In an attempt to classify these communities the survey data were analysed using MATCH. Subsequently, the following five stands were recognised and these were:

- W4 *Betula pubescens-Molinia caerulea*;
- W7 *Alnus glutinosa-Fraxinus excelsior-Lysimachia nemorum;*
- *W8 Fraxinus excelsior-Acer campestre-Mercurialis perennis;*
- *W10 Quercus robur-Pteridium aquilinum-Rubus fruticosus;*
- *W16 Quercus* spp.*-Betula* spp.*-Deschampsia flexuosa.*

Complex species associations occurred within each of these broad categories which, if taken in isolation, showed affinities with other NVC stands. In all five communities a number of species *deviated considerably in* frequency and abundance from the values in the NVC floristic tables which was made apparent by the low coefficient values in the results of the MATCH analysis. Within the oak woodlands species which deviated from the expected frequency and abundance values included *Quercus petraea*, *Holcus mollis, Rubus fruticosus* agg., *Lonicera periclymenum, Teucrium scorodonia*, and *Viola riviniana* (TABLE 6.3.1.1). Subsequently, a number of quadrat samples gave MATCH coefficient values to fit the NVC W11 *Quercus*

FIGURE 6.3.1.1 Floristic table and MATCH Coefficients for two oak woodland stand-types in Wyre: Oak-heath woodland; Mixed oak woodland.

Constant species	Oak-heath woodland	Mixed oak woodland	Rodwell (1991) NVC-W16	Rodwell (1991) NVC-W10
Querc petra	V(7-9)	V(5-9)	II(1-10)	II(3-10)
Bet pend	IV(1-6)	IV(2-8)	IV(1-10)	II(1-10)
Ilex aqui	III(1-5)	III(1-4)	I(1-4)	I(1-7)
Desch flex	V(4-7)	III(1-5)	V(1-9)	I(1-9)
Vacc myrt	V(1-8)	-	II(2-10)	I(1-5)
Call vulga	IV(2-7)	-	II(1-9)	-
Lon peric	IV(1-4)	IV(2-4)	I(1-6)	IV(1-8)
Rub fruti	IV(1-4)	V(2-7)	II(1-7)	IV(1-10)
Pter aqui	III(3-7)	IV(2-7)	IV(1-10)	IV(1-10)
Hol moll	II(1-4)	V(2-10)	I(1-8)	II(1-10)
Teu scoro	III(1-4)	III(1-4)	I(1-5)	I(1-6)
Hya n-scri	I(2)	III(1-5)	I(2-4)	III(1-10)
MATCH coefficient values	W16 42.4 W15 36.5	W10 51.3 W16 41.0		

petraea-Betula pubescens-Oxalis acetosella woodland. In the mixed broadleaved woodland *Quercus* spp. were prominent; species at an unexpectedly high level of presence included *Euphorbia amygdaloides, Ilex aquifolium, Betula pendula, Lamiastrum galeobdolon* and *Viola riviniana*, whilst *Mercurialis perennis* was less abundant than expected which accounted for the high coefficient value in the MATCH analysis for a W10 stand (TABLE 6.3.1.2). The riparian woodland - W7, was characterised by the high proportion of oak in the canopy and an understory dominated by *Corylus avellana.* Furthermore, the abundance of *Allium ursinum, Holcus mollis, Lamiastrum galeobdolon* and *Rubus fruticosus* suggested a community more characteristic of a damp oak woodland than that of alder carr (TABLE 6.3.1.2).

TABLE 6.3.1.2 MATCH coefficient values for mixed broadleaved and riparian woodlands, Wyre

	Mixed broadleaved woodland	Riparian woodlands
MATCH COEFFICIENT	W10 55.8	W7 55.4
VALUES	W8 54.8	W10 49.9
	W12 48.3	W8 46.8
(sub-communities)	W8b 55.5	W7c 56.5
	W10a 54.7	W8a 47.9

A number of species were common to all the forest stand-types and in the oak woodlands there was varying degrees of floristic grading. An analysis of the species data for W10 and W16 stands using Sorenson's Index of Similarity recorded an index value of 65.0 (FIGURE 6.3.1.2) whereas a similar test using data from the NVC floristic tables (Rodwell 1991) gave a value of 35. On repeating the test for species data from the W4:W7 NVC tables a value of 22 was recorded compared to 40.3 given for the sampled data. Likewise, for the published species data for the NVC stand - W8 and W16 the index value was calculated to be 21 compared to a value of 36.7 recorded for the sample data (FIGURE 6.3.1.2).

FIGURE 6.3.1.2 **Sørenson's Index of similarity for the five principal stand-types, Wyre.**

(Index values x100)

	W4	W7	W8	W10	W16
W4	X	40.3	40.0	44.8	33.0
W7	X	X	59.0	57.0	40.4
W8	X	X	X	55.0	36.7
W10	X	X	X	X	65.0
W16	X	X	X	X	X

An analysis of NVC floristic data for four stands using Sorenson's Index of Similarity revealed that similarities between certain communities were not as close as they appeared to be for those same stands surveyed in the field. For the two most extensive communities, W10 and W16 (of which there were more than 30 samples in each stand) there was a large discrepancy between NVC tested data and data taken from the sampled sites

Index values for NVC floristic data

NVC stands (Rodwell 1991)	Index values (x100)
W4:W7	22%
W16:W4	33%
W8:W16	21%
W16:W10	35%

6.3.2 The TWINSPAN classification of the forest vegetation

The TWINSPAN analysis of the full 109 quadrat samples divided the forest ecosystem into two broad vegetation stand-types (TABLE 6.3.2.1 a & b). This was much like the results for the ISA study as the first two polythetic groups distinguished between plant assemblages more typical of free-draining soils and an acidophilous community, and those of a more moist-loving, calcicolous community (FIGURE 6.3.2.1a). The primary division also distinguished between sites situated predominantly on high ground or plateaux (Group 0), and those on hill slopes and valley floors (Group 1) (FIGURE 6.3.2.1b). The mean recorded altitude for plateaux sites was 87m with a range of 45-150m, whilst the mean altitude for the valley sites was 48m with a range of 20m-110m .

Group 0 - Calcifuge forest community

Within this group the preferential species included *Agrostis capillaris, Anemone nemorosa, Deschampsia flexuosa, Holcus mollis, Ilex aquilinum, Luzula sylvatica, Pteridium aquilinum, Teucrium scorodonia* and *Vaccinium myrtillus* . Generally, these plants are favoured by a moderate to low soil base-status with a pH value of less than 5.0 (Grime et al. 1988). Virtually all the National Vegetation Classification quadrats sampled within this major division were located on plateaux or upper valley slopes, and were recognised as homogeneous stands of W10 or W16 woodland with some very small stands of W11. Species showing no preference for either this association or the less acidophilous communities in Group 1 included *Oxalis acetosella, Rubus fruticosus* and *Viola riviniana;* all three were commonly found in valley woodlands. Further down the TWINSPAN division the presence of both *Calluna vulgaris* and *Vaccinium myrtillus* distinguished Group 00 from group 01 although the variance of the principal components was small (eigenvalue was 0.202). Both divisive groups represented a complex and varied assemblage of calcifuge species (TABLE 6.3.2.2).

TABLE 6.3.2.1 a) Species frequency and abundance values for the TWINSPAN Groups in division 0

GROUP 0 DIVISIONS	000	00110	00111	0100	0101	011
Acer pseudoplatanus				I (2)		
Agrostis capillaris	II (1-8)	I (1)		I (1-4)	V (2-8)	I (4)
Agrostis gigantea				I (1)		I (2)
Allium ursinum						
Anemone nemorosa		I (1)		III (1-2)	III (1-2)	IV (1-4)
Anthoxanthum odoratum	I (4)					
Betula pendula	V (1-7)	IV (2-5)	IV (1-5)	V (1-7)	IV (3-8)	III (1-5)
Blecnum spicant				I (2-5)	I (2)	
Brachypodium sylvaticum				I (4)	I (5)	II(3-4)
Calluna vulgaris	III (3-7)	III (3-7)	II (3-5)		I (2)	
Calthus palustris	I (4)					
Carex montana	I (1)					
Carex pallescens	I (1)					
Carex pendula				I (1)		
Convularium majalis			I (3)			
Corylus avellana			II (3-4)	I (2-4)		II (3)
Crataegus monogyna				II (1-4)		III (1-4)
Deschampsia cespitosa				I (1)	I (2)	II (1-3)
Deschampsia flexuosa	V (1-7)	II (4-6)	IV (1-9)	II (1-4)	II (4-5)	III (2-5)
Dicranium sp	I (1)	I (2-3)				
Dryopteris dilatata				I (2-4)		I (1-2)
Dryopteris filix-mas				I (2-4)	I (1)	
Epilobium angustifolium			I (1)			
Euphorbia amygdaloides				I (1)	I (1)	IV (1-2)
Galium palustre						I(1-2)
Galium saxatile	III(1-4)		I (2)	I (1)	III (1-2)	
Geum urbanum					I (3)	
Hedera helix			II (1-3)	I (1)		
Holcus mollis	III (1-5)	I (1-4)	IV (1-8)	IV (1-10)	IV (3-7)	III (2-4)
Hyacinthoides non-scripta			I (1)	II (1-5)	I (1)	III (1-3)
Hypericum pulchrum	I (2)			I (1-2)	III (1-3)	I (1)
Ilex aquifolium	I (1)	III (1-5)	II (1-5)	III (1-4)	III (1)	I (1-4)
Juncus effusus				I (4)	I (1)	
Juncus inflexus						
Lamiastrum galeobdolon					I(1)	II (1-4)
Lolium perenne						
Lonicera periclymenum	III (1-4)	IV (1-4)	V (1-4)	V (1-5)	V (1-3)	IV (1-3)
Luzula campestris	I (1)				III (1-2)	
Luzula pilosa						
Luzula sylvatica	II (1)		II (1-9)	I (1-6)	III (2-3)	I (1)
Lysimachia nemorum				I (1-2)	I (1)	I(1-3)
Malus sylvestris				I (1)	II (1-3)	
Melica uniflora				I (4)		IV(2-5)
Milium effusum					I (1)	
Mnium hornum			I (3)	I(1-2)	I(1)	
Mnium longifolium			I (3)			
Molinia caerulea				I (7)		
Oxalis acetosella				II (1-3)	II (1-3)	III(2-3)
Poa nemoralis						
Poa trivialis						
Polygonum sp		I (1-4)	II (1-4)	I (1-2)	I (1)	I (2)
Populus tremula				I (2-3)		
Potentilla erecta	I (1)				III (1-3)	
Potentilla sterilis				I(2)	II (1-2)	I(2)
Primula vulgaris						
Prunus avium				I (4)		
Pseudosasa sp	I (4)	I (2)				
Pteridium aquilinum	IV(1-6)	IV 1-5)	IV 2-6)	V (2-8)	IV (4-9)	IV (4-5)
Quercus petraea	III(1-6)	V (1-9)	V (2-9)	V (1-9)	IV (4-9)	IV (1-9)
Ranunculus repens					I (1)	
Rosa canina				I (2)	I (3)	I(1-2)
Rubus fruticosus	III (1-9)	III(1-4)	V (1-8)	V (1-7)	V (2-4)	IV (1-4)
Salix cinerea	I (1)			I (4)		
Sorbus aucuparia			II (1-2)	II (1-2)	I (1)	IV (1-3)
Sorbus torminalis	I (2)		I (2)	I (1-2)		I(1-2)
Sphagnum sp						
Taxus baccata				I (1-2)		
Teucrium scorodonia	III (1-4)	I (3)	III (1-3)	II (1-4)	III (1-2)	IV(2-4)
Vaccinium myrtillus	IV(3-7)	V (1-8)	V (1-7)	II (1-6)	I (1)	
Viburnum opulus				I (1)	I (1)	
Viola riviniana	I (2)		I (1)	III (1-3)	III (1-4)	V(1-4)
Number of samples:	8	12	10	32	7	8

TABLE 6.3.2.1 B) Species frequency and abundance values for the TWINSPAN Groups in division 1

GROUP 1 DIVISIONS	1000	1001	1010	1011	11
Acer campestre					
Acer pseudoplatanus		I (1)	II (1-7)	II (5)	
Agrostis capillaris	III (2)				
Agrostis gigantea					
Allium ursinum		III (5-9)	I (4)		
Alnus glutinosa		IV(5-7)	III(3-7)		IV(4-8)
Anemone nemorosa		I (1-5)	I (1)	II (1)	
Angelica sylvestris	III (2)				II (2)
Arum maculatum			I (2)	II (1)	
Athyrium filix-femina	III (3)	III (2-3)			
Betula pendula	III (7)	I (4)	III 4-8)		
Betula pubescens					V(6-8)
Brachypodium sylvaticum			I (4)	IV (1-7)	II (2)
Bromus ramosus		I(1-2)		II (1-5)	
Cardamine pratense	III (1)				
Carex flacca					V (4-5)
Carex pendula	V (4-5)	II (4-8)			
Carex pilulifera					
Carex remota	III (7)	I (2)			
Carex sylvatica					
Chryosplenium oppisitofolium	III (4)				
Circaea lutetiana	III (5)	II (1-4)			
Cirsium palustre					
Cornus sanguineum		I (1)		I1(2)	
Corylus avellana	I(4)	III (4-10)	V (6-9)	IV (5)	II(5)
Crataegus monogyna		I (1-2)	IV (1-4)	V (1-7)	
Deschampsia cespitosa	III (1)	II (3-5)	III (1-4)		
Dryopteris dilatata	III (1)		II (1-4)		
Dryopteris filix-mas		I (2)	III (1-4)	III (1-4)	
Epilobium angustifolium				II (4)	
Epilobium montanum					
Equisetum palustre					V (1-3)
Euphorbia amygdaloides		I (1)	III (1-2)		II (1)
Festuca rubra					
Fragaria vesca		I(1-2)		II (4)	
Fraxinus excelsior		II (2-5)	III (1-4)	V (1-8)	
Galium aparine				II (1)	
Galium palustre	III (2)				II (1)
Geranium robertianum	III (2)	I (1)		III (1-3)	
Geum urbanum		I (2)	I (1)	III (2-4)	
Glechoma hederacea				IV (3)	
Hedera helix			I (2)	IV (3-4)	
Holcus mollis		II (3-5)	III (4-8)		
Hyacinthoides non-scripta		II (4-7)	III (2-5)		
Ilex aquifolium	III(2)		III (1-2)	III (1-2)	
Iris pseudacorus					
Juncus articulosus					
Juncus effusus		I (1)			
Juncus inflexus					
Lamiastrum galeobdolon		II (2-4)	III (2-4)		
Lonicera periclymenum		II (1-3)	III (2-5)	II (1)	
Luzula sylvatica			I (1)	II (1)	
Lysimachia nemorum	III (2)	II (1-2)			
Melica uniflora	III (1)	I (2)		III (4-5)	
Mercuralis perennis		II (2-6)	I (4)	IV (4-5)	
Milium effusum			I (3)	III (1-2)	
Mnium hornum		II (1-2)	III (1-2)	II (3)	
Mnium undulatum		I(1-2)	I (2)	III (1-2)	II (3)
Molinia caerulea					V (7-9)
Oxalis acetosella	III (2)	II (1-4)	III (2-4)		
Poa trivialis					
Populus tremula		I (5)	III (5)		
Potentilla sterilis		I (1)		II (1)	
Primula vulgaris					
Prunus avium		I (3-4)		V (1-5)	
Pteridium aquilinum		I (3-4)	I (1)		
Quercus petraea	V (5-9)	IV (1-8)	V (1-8)	III (1-5)	IV (4)
Ranunculus flammula					
Ranunculus repens	V (4)				
Rosa canina		I (1)	I (1)	II (2)	
Rubus fruticosus	V (2-3)	II (1-3)	V (1-8)	III (5-7)	V (1)
Rumex obtusifolius					
Salix cinerea		I (3-4)		III (2-5)	II(3-5)
Solanum dulcamara					
Sorbus aucuparia	III (4)		I (1-2)		
Sorbus torminalis	III (3)				
Stachys sylvatica	I (5)	I (1)	I (2)	III (1-2)	
Stellaria nemorosa			III (1)	II (2)	
Taxus baccata	III (3)				
Teucrium scorodonia			I (2)	II (3)	
Tilia cordata					
Urtica dioica	III (5)			II (4)	
Vaccinium myrtillus					II (2)
Valeriana officinalis					
Veronica chamaedrys					
Veronica montana		I (1-2)	II (1-2)		
Viburnum opulus		II (1-2)			
Viola riviniana		I (1-2)	V (1-4)	IV (1-3)	II (1-3)
Number of samples	2	10	7	4	3

FIGURE 6.3.2.1 a) Representation of the frequency occurrence of species in twelve TWINSPAN polythetic Groups, Wyre Forest

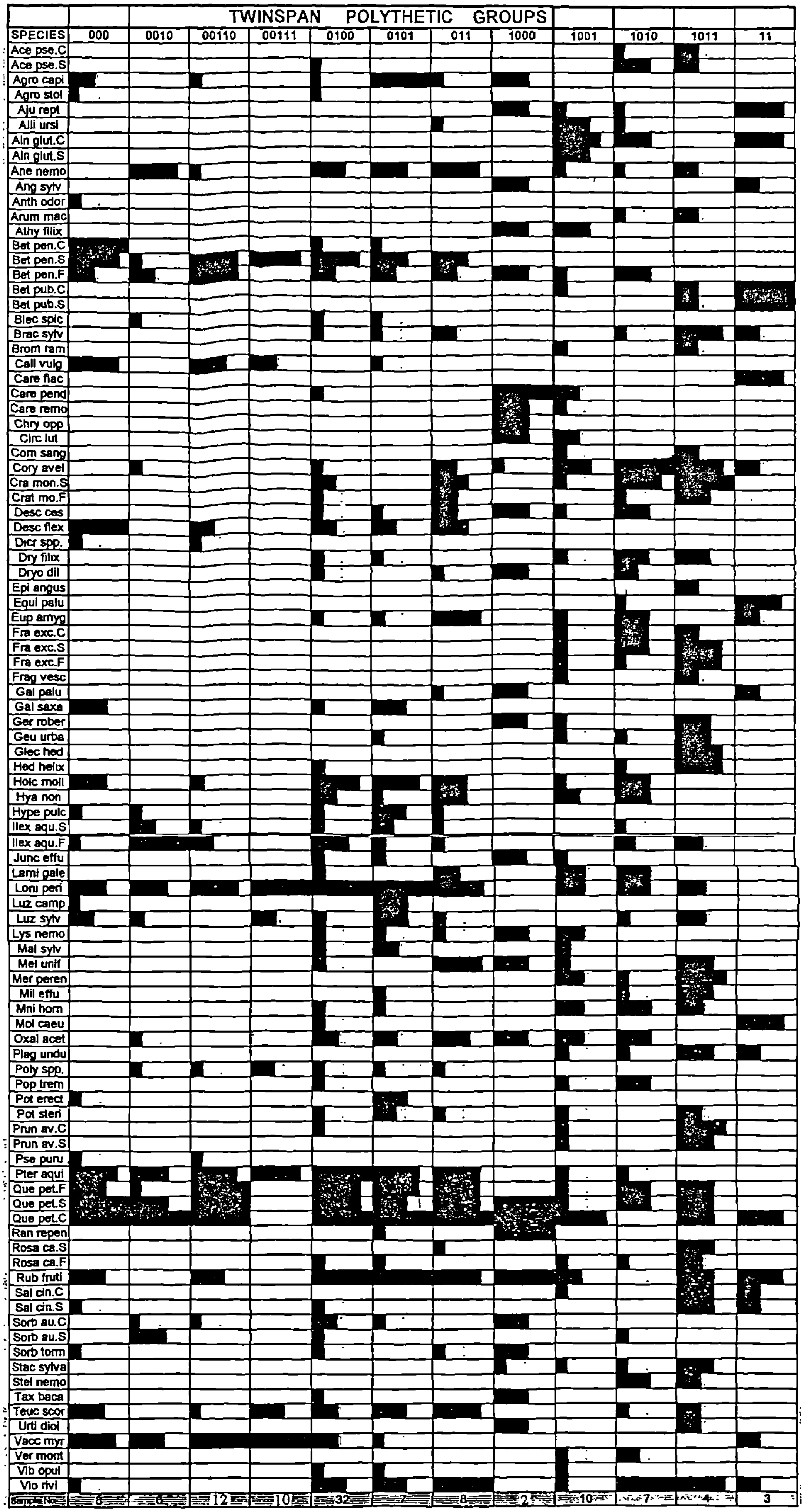


FIGURE 6.3.2.1 b) TWINSPAN classification of the semi-natural stands, Wyre Forest (Eigenvalues are given for each division)

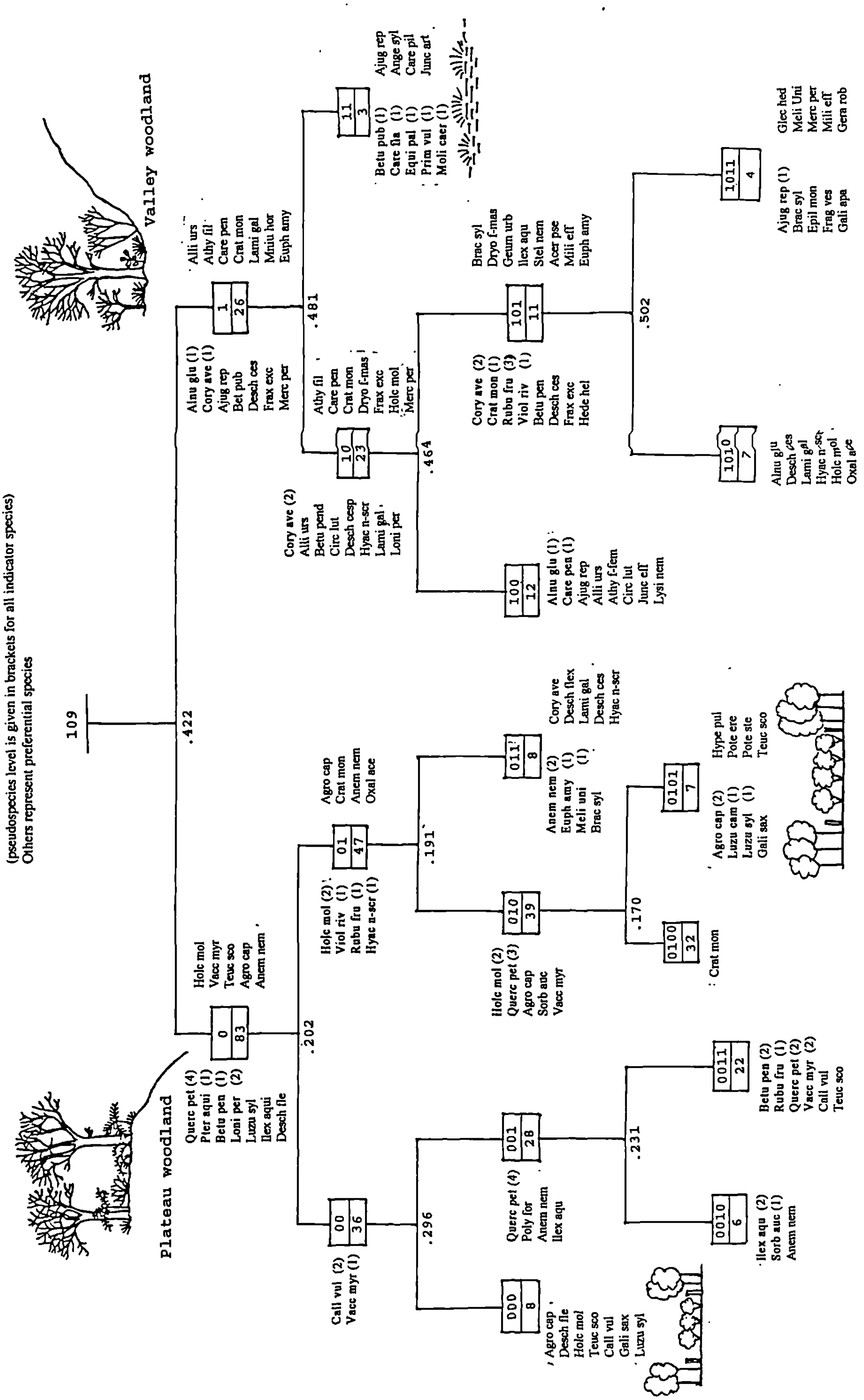


TABLE 6.3.2.2 The floristic table of constant species for the two divisive Groups - 00 & 01, and two NVC woodland stand-types taken from Rodwell (1991) .

SPECIES	*Group 00*	*Group 01*	*NVC W10*	*NVC W16*
Quercus petraea	*V(8-10)*	*V(8-10)*	*II(2-9)*	*II(1-9)*
Betula pendula	*IV(1-6)*	*IV(1-6)*	*II(1-9)*	*IV(1-9)*
Vaccinium myrtillus	*V(1-9)*	*I(1-6)*	*I(1-5)*	*II(2-9)*
Rubus fruticosus agg.	*V(1-8)*	*V(1-6)*	*IV(1-9)*	*II(1-7)*
Deschampsia flexuosa	*IV(1-9)*	*II(1-5)*	*I(1-9)*	*V(1-9)*
Holcus mollis	*IV(1-9)*	*V(4-9)*	*II(1-9)*	*I(1-8)*
Pteridium aquilinum	*IV(1-6)*	*IV(2-7)*	*IV(1-9)*	*IV(1-9)*
Lonicera periclymenum	*IV(1-4)*	*IV(1-4)*	*IV(1-8)*	*I(1-6)*
Viola riviniana	*I(1-3)*	*III(1-4)*	*I(1-4)*	-
Teucrium scorodonia	*II(1-4)*	*III(1-4)*	*I(1-6)*	*I(1-5)*
Ilex aquifolium	*III(1-5)*	*III(1-4)*	*II(1-9)*	*II(2-4)*
Hyacinthoides non-scripta	*I(1-2)*	*III(1-5)*	*III(1-9)*	*I(2-4)*

(Roman numerals represent the frequency values, those in brackets are the range of DOMIN scores)

Group 00 contained samples which could be broadly identified with the *NVC* *Quercus* spp.-*Betula* spp.-*Deschampsia flexuosa* woodland although a number of the quadrat readings registered as conforming to W10 *Quercus spp.-Pteridium aquilinum-Rubus fruticosus* agg., and W11 *Quercus petraea- Betula pubescens-Oxalis acetosella* in the MATCH analysis. This was associated with the high levels of occurrence of *Holcus mollis, Lonicera periclymenum, Rubus fruticosus* and *Vaccinium myrtillus*. However, an analysis of Group 00 using MATCH coefficiency testing gave a coefficient value of 42.4 for W16. The non-preferential species included *Deschampsia* *flexuosa, Ilex aquifolium, Lonicera periclymenum, Pteridium aquilinum, Rubus fruticosus* agg. and *Teucrium scorodonia.*

Group 01 was distinguished from the previous vegetation-type by the presence of the following indicator species: *Agrostis capillaris, Anemone nemorosa, Crataegus monogyna, Holcus mollis, Hyacinthoides non-scripta, Oxalis acetosella* and *Viola riviniana*. The assemblage of species in this group suggested an affiliation to the NVC W10 stand-type and in practice a MATCH analysis for Group 01 samples recorded a coefficient value of 51.3 for the NVC W10 stand-type, and 41.0 for the NVC W16 stand-type. Again, as in the last divisive group, twelve of the samples gave a closer MATCH affiliation to the NVC W11 stand-type.

Division of Group 00

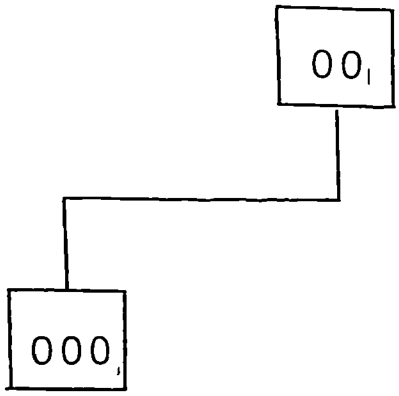
Further division of Group 00 identified a small cluster of samples - Group 000, taken from recently felled coppice coupes scattered throughout the reserve (FIGURE 6.3.2.2a). These samples were analysed earlier using MATCH and were recognised as sharing some floristic characteristics with the NVC W16 stand-type (TABLE 6.3.2.3).

TABLE 6.3.2.3 MATCH coefficient values calculated for the TWINSPAN Group 000

MATCH COEFFICIENT VALUES	
STAND-TYPE	SUB-COMMUNITY
W16 41.1	W16b 42.2
W17 35.7	W17b 38.1
W11 34.5	-

The indicator species identified in the TWINSPAN analysis for this divisive Group were *Agrostis capillaris, Calluna vulgaris, Deschampsia flexuosa, Galium saxatile* and *Holcus mollis* although *Vaccinium myrtillus* was also abundant. However, the species recorded in this cluster of samples showed considerable deviation from the published NVC data set both in frequency occurrence and abundance (FIGURE 6.3.2.2b), which explains the rather low MATCH

FIGURE 6.3.2.2 a) Floristic table for the TWINSPAN polythetic group - 000



Group 000 Constant species	Sample data	Constancy table Rodwell (1991)
Deschampsia flexuosa	V (2-8)	V (1-9)
Teucrium scorodonia	V (1-4)	I (1-5)
Calluna vulgaris	IV (1-7)	II (1-9)
Vaccinium myrtillus	IV (1-7)	II (2-10)
Pteridium aquilinum	IV (1-6)	IV (1-10)
Rubus fruticosus	IV (1-9)	II (1-7)
Lonicera periclymenum	IV (1-4)	I (1-6)
Holcus mollis	IV (1-5)	I (1-8)
Agrostis capillaris	II (1-8)	I (3-7)
Match coefficients	W16 41.1 W17 35.7 W11 34.5	W16

Floristic table and MATCH coefficients for group 000

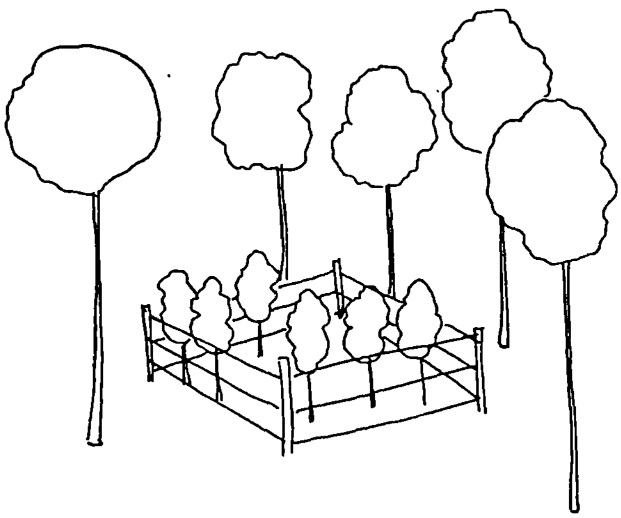
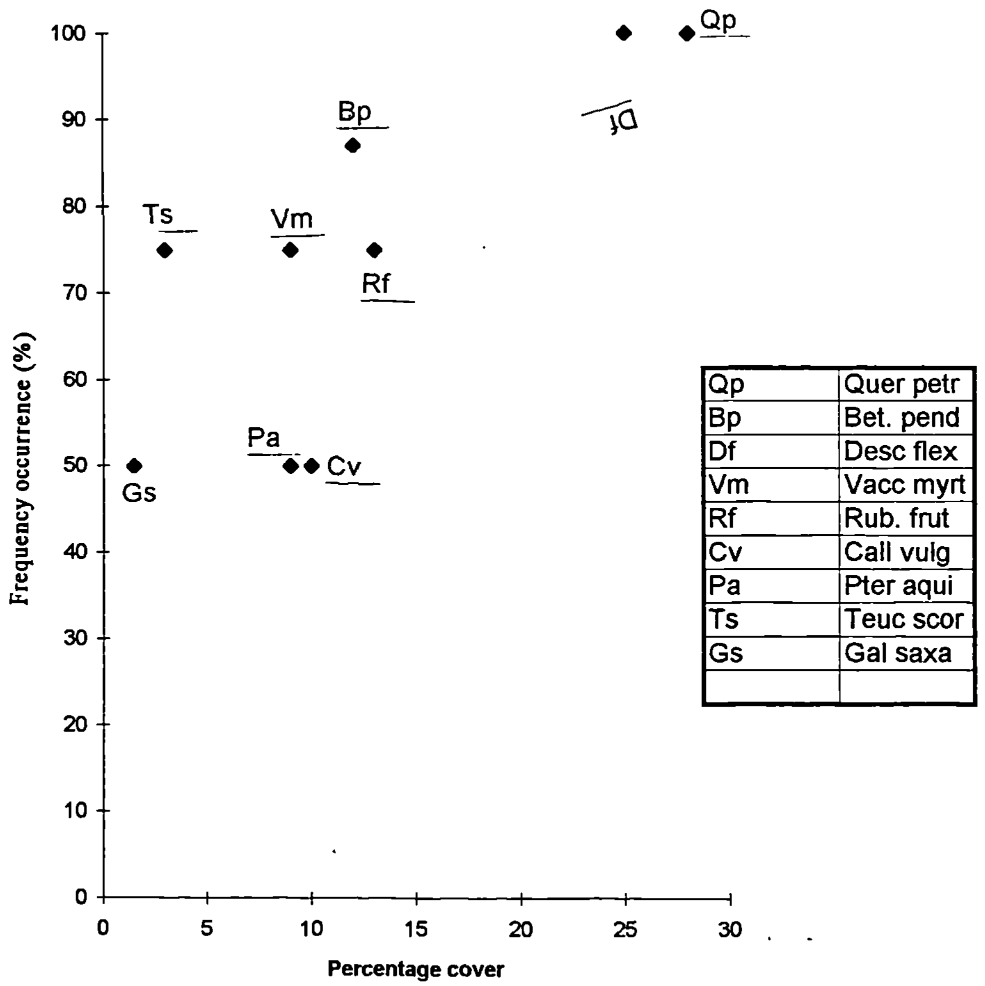


FIGURE 6.3.2.2 b) Frequency and abundance values of constant species, TWINSPAN Group 000



to the NVC W16 stand. The assemblage of species in Group 000 shared characteristics with the NVC W11 community described by Rodwell (1991).

A comparison between Group 000 and its counterpart - Group 001 made reveals some differences between these two TWINSPAN groups (TABLE 6.3.2.4) although several species were similarly represented. The indicator species for Group 001 were *Anemone nemorosa, Ilex aquilinum* and *Polytrichum formosum*. Non-preferential species included *Lonicera periclymenum, Pteridium aquilinum, Rubus fruticosus* and *Vaccinium myrtillus*. Within Group 001 was a cluster of 6 samples which were all located in the south-western quarter of the forest (SO7374, SO7474) and were identified in Group 0010. Whilst a MATCH analysis made no distinction between W10 and W16 coefficient values for this group, this part of Wyre was distinct from other areas of the forest because of the high proportion of mature holly and rowan retained in the canopy and understory. The species serving as indicators for Group 0010 were *Anemone nemorosa, Ilex aquilinum* and *Sorbus aucuparia*. Finally, the division of Group 0011 produced two clusters (Groups 00110 & 00111). Generally, the sites within Group 00111 were located on the slopes of small gullies or on steep-sided valley ridges where the average altitude was 79m. The indicator species for this group were *Anemone nemorosa, Luzula sylvatica, Sorbus aucuparia* and *Teucrium scorodonia*. At the opposing end of the division the sites within Group 00110 were scattered throughout the forest but generally on higher ground with a mean altitude of 107m. Furthermore, the gradient of slope in these locations was not so steep. The representative species for Group 00110 were *Deschampsia flexuosa* and *Holcus mollis*.

TABLE 6.3.2.4 Floristic table of constant species for TWINSPAN Groups 000 and 001

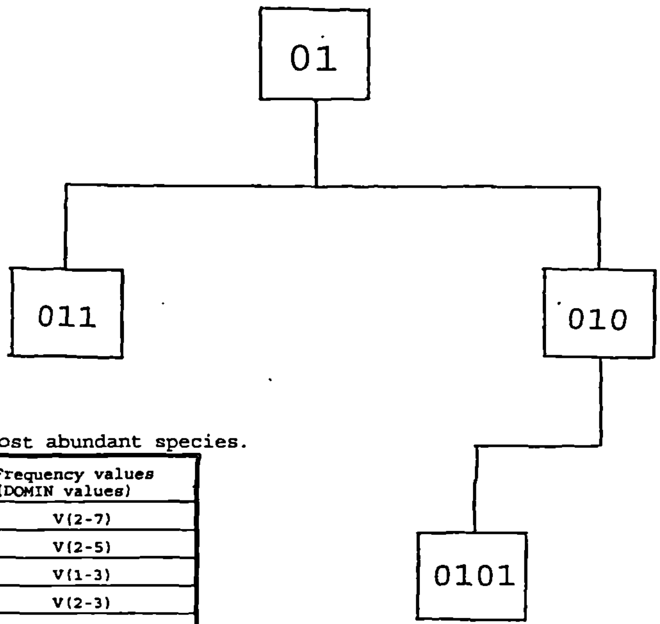
SPECIES	GROUP 000	GROUP 001
Quercus petraea	-	*V (7-10)*
Betula pendula	-	*V (2-5)*
Rubus fruticosus agg.	*IV (1-9)*	*V (1-8)*
Vaccinium myrtillus	*IV (1-7)*	*V (1-8)*
Deschampsia flexuosa	*V (2-8)*	*IV (1-6)*
Pteridium aquilinum	*IV (1-6)*	*IV (1-5)*
Lonicera periclymenum	*IV (1-4)*	*IV (1-4)*
Holcus mollis	*IV (1-5)*	*IV (1-9)*
Calluna vulgaris	IV (1-7)	II (3-7)
Ilex aquifolium	-	III (1-5)
Teucrium scorodonia	V (1-4)	II (1-3)

TWINSPAN Group 01

The division of Group 01 identified a small collection of steep-sided valley ridge sites (Group 011) which had a mean altitude of 64m; and an opposing cluster of many more sites on mainly plateaux or gentle slopes (Group 010) with a mean altitude of 110m. Of the two divisions, Group 011 was more species-rich with an abundance of *Melica uniflora*. Other indicator species included *Brachypodium sylvaticum, Corylus avellana, Deschampsia flexuosa, Euphorbia amygdaloides, Hyacinthoides non-scripta, Lamiastrum galeobdolon* and *Viola riviniana* (FIGURE 6.3.2.3). The MATCH coefficient values for this group were W10-47.4, W16-38.1 and W11-38.1. Group 010 was identified by the presence of *Agrostis capillaris, Holcus mollis, Sorbus aucuparia* and *Vaccinium myrtillus*. A further division of this large group identified another small cluster of samples (Group 0101) taken from sites which had at some time experienced disturbance, or had recently been coppiced. The MATCH coefficient values for this assemblage were W11-41.8, W10-42.4 and W16-29.6 and the preferential species included *Agrostis capillaris, Galium saxatile, Hypericum pulchrum, Luzula campestris, Potentilla erecta* and P.*sterilis* (FIGURE 6.3.2.3). Group 0100 was distinguished from Group 0101 by the presence of hawthorn. However, many species remained common to both stands; these included *Anemone nemorosa, Deschampsia flexuosa, Holcus mollis, Hyacinthoides non-scripta, Ilex aquifolium, Lonicera periclymenum, Oxalis acetosella* and *Rubus fruticosus* agg. Further division of Group 0100 identified a small collection of sites all of which were located low down valley slopes or at the bottom of steep gullies. The presence of *Blechnum spicant, Deschampsia cespitosa, Dryopteris filix-mas, Juncus effusus* and *Viburnum opulus* indicates a moist environment in contrast to the drier vegetation type associated with sites in Group 01001. The cluster of samples in this latter group were identified by the presence of *Anemone nemorosa, Hyacinthoides non-scripta, Pteridium aquilinum* and *Teucrium scorodonia.* However, despite the distinction made in the analysis between these two groups the variance of the principal components was low (Eigenvalue reading was 0.160). Furthermore, there was the occurrence in both groups of common species including *Holcus mollis, Lonicera periclymenum, Oxalis acetosella, Rubus fruticosus* agg. and *Viola riviniana.*

Out of the numerous samples which made up the Group 01 series nine were affiliated through the MATCH programme with the NVC W11 woodland community. These quadrats shared a number of species which contributed to a characteristic assemblage (TABLE 6.3.2.5). However, the rather infrequent combination of *R.fruticosus* and *L.periclymenum* in abundance with *A.capillaris, Potentilla erecta* and *Galium saxatile* was not represented in the NVC classification. Furthermore, the frequent occurrence of *T.scorodonia* was not as apparent in either NVC W10 or W11 communities given by Rodwell (1991). A common feature to all nine sites sampled was the extent of recent disturbance to the canopy. Three had been coppiced in the last two years and consequently had no canopy cover. The remainder had experienced similar activity over a

FIGURE 6.3.2.3 Floristic tables for the TWINSPAN polythetic groups - 011 & 0101



Floristic table of the most abundant species.

Constant species for group 011	Frequency values (DOMIN values)
Melica uniflora	V(2-7)
Rubus fruticosus	V(2-5)
Lonicera periclymenum	V(1-3)
Euphorbia amygdaloides	V(2-3)
Holcus mollis	IV(2-6)
Pteridium aquilinum	IV(1-5)
Deschampsia flexuosa	IV(2-4)
Teucrium scorodonia	IV(1-4)
Hyacinthoides non-scripta	IV(1-5)

Group 0101 Species	Sample data	Constancy table Rodwell (1991)
Rubus fruticosus Agg	V (3-4)	IV (1-10)
Holcus mollis	V (2-7)	II (1-10)
Pteridium aquilinum	V (4-9)	IV (1-10)
Teucrium scorodonia	V (1-3)	I (1-6)
Luzula campestris	V (1)	absent
Agrostis capillaris	V (2-8)	I (1-9)
Luzula sylvatica	IV (2-3)	I (1-9)
Deschampsia flexuosa	IV (1-6)	I (1-9)
Match coefficients	W10 42.4 W11 41.8	W10

Floristic table and MATCH coefficient for group 0101

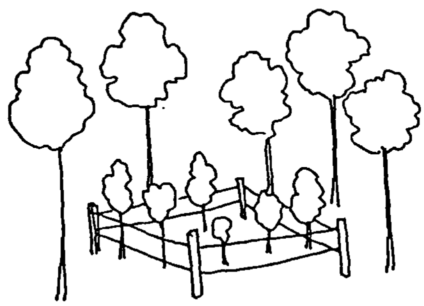


TABLE 6.3.2.5 Species which were characteristic of the assemblages classified as NVC W11 stand-types.

species	TEST DATA	NVC W11 (Rodwell 1991)
Rub frut	V	I(1-8)
Holc moll	V	IV(1-8)
Pter aqui	IV	IV(1-9)
Agro cap	IV	IV(1-9)
Loni peri	IV	II(1-6)
Teuc scoro	IV	II(1-7)
Pote erect	IV	IV(1-7)
Gali saxa	IV	IV(1-6)
Desc flex	III	IV(1-8)
Ver offic	II	II(1-4)
Hyp pulch	II	II(1-3)

period of 20 and 40 years as indicated by the relatively high proportion of intermediate sized stems (TABLE 6.3.2.6).

TABLE 6.3.2.6 Comparative measure of stem density between the nine W11 classified sites and the other 100 sites from the Wyre Forest.

Size class:	0-8 (cm)	9-16 (cm)	17-25 (cm)	26-34 (cm)	35-43 (cm)
Mean No. Of stems/200 m^2	12.6	12.6	3.6	1.3	2
Average No. Of stems/200 m^2 for Wyre	6.9	2.6	2.5	1.6	2

Group 1 - less acidophilous forest community

The pattern of division of Group 1 was similar to that of the samples analysed in the ISA study in that both wet and base-rich sites were associated together in the top divisive group. The preferential species included *Ajuga reptans, Allium ursinum, Alnus glutinosa, Athyrium filix-femina, Betula pubescens, Carex pendula, Corylus avellana, Dryopteris filix-mas, Euphorbia amygdaloides, Fraxinus excelsior, Lamiastrum galeobdolon* and *Mercurialis perennis*. However, these woodlands had a number of species in common with the more calcifuge community including *Betula pendula, Holcus mollis, Oxalis acetosella, Quercus* hybrids and *Viola riviniana.* In the case of oak this tree continued to be a dominant component of the canopy in the valley woodlands.

The division of Group 1 made a distinction between a small cluster (Group 11) of wooded marshland, which showed some affinity to the NVC W4 - *Betula pubescens-Molinia caerulea* stand, and mixed deciduous woodlands (Group 10). The preferential species for the former group were *Angelica sylvestris, Betula pubescens, Equisetum palustre, Molinia caerulea, Primula vulgaris* and *Vaccinium myrtillus*. Whilst these flushes were small and scattered they were linked by springlines to the riparian woods which may have accounted for the high proportion of species common to both vegetation types including *Alnus glutinosa, Brachypodium sylvaticum, Euphorbia amygdaloides, Plagiothecium undulatum, Rubus fruticosus, Salix cinerea* and *Viola riviniana.* Furthermore, a MATCH analysis of the mire woods gave values of W7-29.8 and W4-29.1 which suggest strong affinities to the riparian alder woods. However, despite the similarities between these two woodland habitats, the Eigenvalue given for the division of Group 1 was 0.481 which suggests a good distinction between the two TWINSPAN Groups - 10 and 11. The prominence of *Molinia caerulea* in the field layer throughout the Wyre birch mire stands helps to distinguish these sites as having an affinity to the NVC W4 *Betula pubescens- Molinia caerulea* stand.

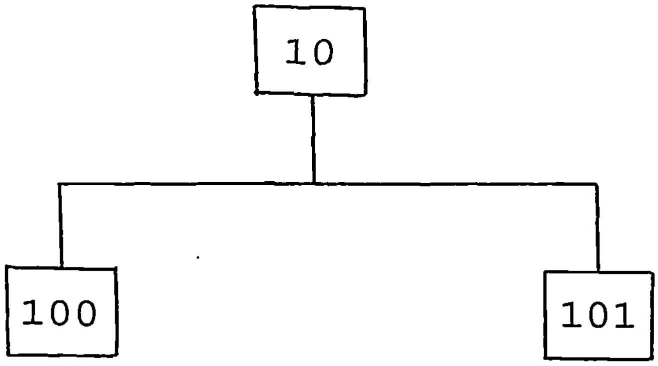
Division of the TWINSPAN Group 10

The much larger cluster of samples in Group 10 were recorded from in the valley areas and lower hill slopes in which the homogeneous stands were identified as being W7 *Alnus glutinosus-Fraxinus excelsior-Lysimachia nemorum,* and W8 *Fraxinus-Acer campestre-Mercurialis perennis* (TABLE 6.3.1.2). The preferential species for this group included *Allium ursinum, Athyrium filix-femina, Carex pendula, Circaea lutetiana, Crataegus monogyna, Deschampsia cespitosa, Dryopteris filix-mas, Fraxinus excelsior, Hyacinthoides non-scripta, Lamiastrum galeobdolon, Mercurialis perennis* and *Mnium hornum.* Further division of Group 10 made clearer the distinction between riparian woodland (Group 100) and mixed deciduous woodland of more free-draining soil (Group 101), (FIGURE 6.3.2.4). The Eigenvalue for this division was given as 0.464 Furthermore, when these two groups were then analysed using Sorenson's coefficient of similarity they gave a value of 0.59 (35 species common to both, 70 species in Group 100 and 50 species in Group 101). A MATCH analysis of Groups 100 and 101 illustrated the problems of attempting to classify Wyre Forest communities using the NVC (TABLE 6.3.2.7).

TABLE 6.3.2.7 MATCH values for two TWINSPAN Groups, 100, and 101

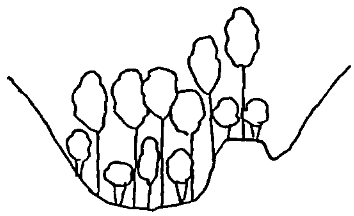
Polythetic group	NVC Stand-type	MATCH value
100	*Alnus glutinosa-Fraxinus excelsior-Lysimachia nemorum*	W7-55.4 W10-50 W8-47
101	*Fraxinus excelsior-Acer campestre-Mercurialis perennis*	W10-55.8 W8-54.8 W12-48.3

FIGURE 6.3.2.4 Floristic tables for the TWINSPAN polythetic groups - 100 & 101



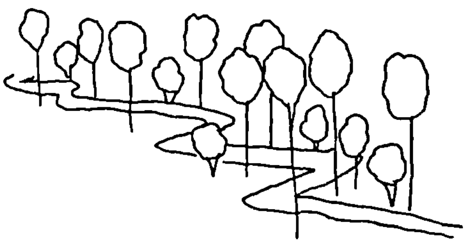
Group 101 Constant species	Sample data	Constancy table Rodwell (1991)
Quercus spp	V (7)	I (2-9)
Corylus avellana	V (6)	V (1-10)
Rubus fruticosus agg.	V (5)	IV (1-10)
Crataegus monogyna	IV (4)	III (1-7)
Viola riviniana	IV (2)	I (1-7)
Fraxinus excelsior	IV (5)	IV (1-10)
Mercurialis perennis	IV (4)	V (1-10)
Euphorbia amygdaloides	III (1)	I (1-5)
Lamiastrum galeobdolon	III (4)	III (1-10)
Hedera helix	III (2)	III (1-10)
Match coefficients	W10 55.8 W8 54.8 W12 48.3	W8

Floristic table and MATCH coefficients for group 101



Group 100 Constant species	Sample data	Constancy table Rodwell (1991)
Corylus avellana	V (7)	II (1-8)
Alnus glutinosa	V (6)	IV (1-10)
Quercus spp	V (5)	I (1-6)
Rubus fruticosus agg.	IV (4)	II (1-8)
Lamiastrum galeobdolon	IV (4)	I (3-4)
Allium ursinum	III (5)	?
Fraxinus excelsior	III (4)	III (1-7)
Holcus mollis	III (4)	III (1-8)
Deschampsia cespitosa	III (4)	III (1-9)
Carex pendula	III (4)	I (1-7)
MATCH coefficients	W7 55.4 W10 49.9 W8 46.8	W7

Floristic table and MATCH coefficients for group 100



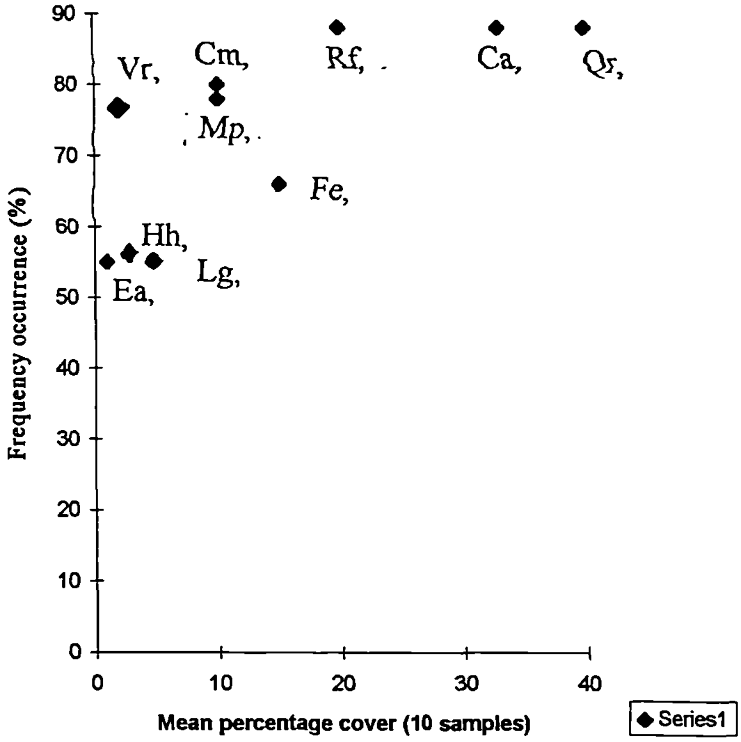
Oak was a constant species in the canopy in all the valley stands and, similarly, hazel was the dominant component of the understory. Other species common to both stands were *Holcus mollis, Hyacinthoides non-scripta, Lamiastrum galeobdolon, Lonicera periclymenum, Mercurialis perennis, Mnium hornum, Oxalis acetosella, Plagiothecium undulatum* and *Rubus fruticosus*.

The results of the MATCH analysis suggested that the valley woodlands did not easily fit the relevant NVC categories but rather these forest sites shared characteristics with more than one of the published communities, in particular with the NVC W10 *Quercus - Pteridium - Rubus* stand. Indeed both the ash-oak and alder-oak stands had a distinctive character of their own. The Preferential species for Group 101 included *Acer pseudoplatanus, Crataegus monogyna, Deschampsia cespitosa, Dryopteris filix-mas, Euphorbia amygdaloides, Fraxinus excelsior, Geum urbanum, Hedera helix, Milium effusum, Prunus avium* and *Viola riviniana* and these species together with a few others (FIGURE 6.3.2.5) were well represented. Group 101 showed some similarity with the NVC W8 *Fraxinus excelsior-Acer campestre-Mercurialis perennis* stand-type. The alder-oak stands along the river valleys supported an association of species which helped to match all of these sites represented in the TWINSPAN Group 100 with the NVC W7-*Alnus glutinosa-Fraxinus excelsior-Lysimachia nemorum* stand type. Species included in these stands were *Allium ursinum, Ajuga reptans, Alnus glutinosa, Athyrium filix-femina, Carex pendula, Juncus effusus* and *Lysimachia nemorum* (FIGURE 6.3.2.6).

Division of the oak-ash woodlands of TWINSPAN Group 101

The division of Group 101 identified a split between oak-ash stands associated with the railway embankment (Group 1011) and those stands which formed part of the riparian woodland along the river Severn and its tributaries (Group 1010). The riverside stands had several species in common with the adjacent alder woods including *Alnus glutinosa, Lamiastrum galeobdolon, Deschampsia cespitosa, Dryopteris dilatata, Holcus mollis* and *Oxalis acetosella*. They also shared several constants with W10 stand-types in the forest which accounted for the MATCH coefficient values of W10-54.1 and W8-45.5.

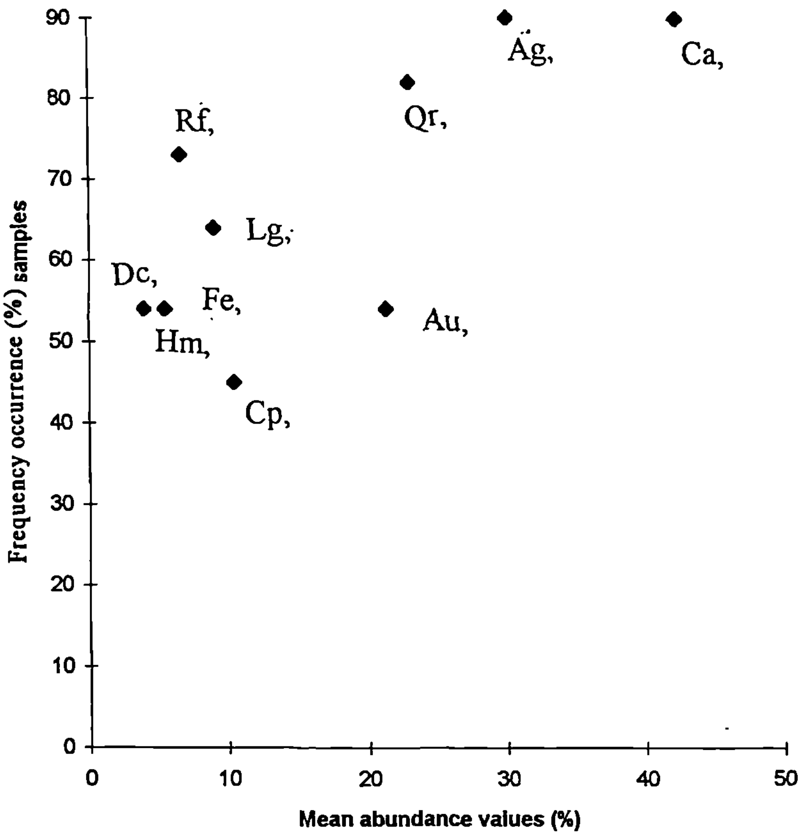
FIGURE 6.3.2.5 Abundance and frequency values for the principal species of ash-oak woodland, TWINSPAN Group 101



KEY:

Qr, *Quercus hybrid*
Ca, *Corylus avellana*
Rf, *Rubus fruticosus*
Cm, *Crataegus monogyna*
Vr, *Viola riviniana*
Fe, *Fraxinus excelsior*
Mp, *Mercurialis perennis*
Ea, *Euphorbia amygdaloides*
Hh, *Hedera helix*
Lg, *Lamiastrum galeobdolon*

FIGURE 6.3.2.6 Abundance and frequency values for the principal species of alder-oak woodland, Wyre, TWINSPAN group 100



KEY:

Ca, *Coryuls avellana*
Ag, *Alnus glutinosus*
Qr, *Quercus hybrid*
Rf, *Rubus fruticosus*
Lg, *Lamiastrum galeobdolon*
Fe, *Fraxinus excelsior*
Au, Allium ursinum
Hm, *Holcus mollis*
Dc, *Deschampsia cespitosa*
Cp, *Carex pendula*

Other similarities between the riverside stands and the railway woods included the common occurrence of *Acer pseudoplatanus, Anemone nemorosa, Arum maculatum, Euphorbia amygdaloides, Luzula sylvatica, Milium effusum* and *Viola riviniana*. However, there were noticeable distinctions in composition between the two oak-ash woodlands; the railway line supported a substantial cover of *Acer campestre, Brachypodium sylvaticum, Galium aparine, Geranium robertianum, Geum urbanum, Glechoma hedera, Melica uniflora, Milium effusum, Mercurialis perennis* and *Urtica dioica,* all of which were much less common along the riverside. The virtual absence of alder and the relatively low abundance of oak along this man-made feature also provided a greater similarity to the NVC W8 stand-type. The structure of the rail line woodland was characteristically pioneer with a disproportionately high number of young trees (TABLE 6.3.2.8).

TABLE 6.3.2.8 Comparison of forest structure between two TWINSPAN Groups: 1010 and 1011

TWINSPAN groups	Stem size class	
	(0-24cm dbh) No./ 1000m^2	(25cm+ dbh) No./1000m^2
1010 (riverside)	55	11
1011 (embankment)	200	0

An analysis of this distinction using X^2 gave a value of X^2 = 81.6, 1^0 of freedom, at 5% level, critical value for X^2 = 3.84.
The environmental continuum between the riverside woods and adjacent ash-oak stand-types was much more apparent and this would have provided greater opportunities for floristic grading between them.

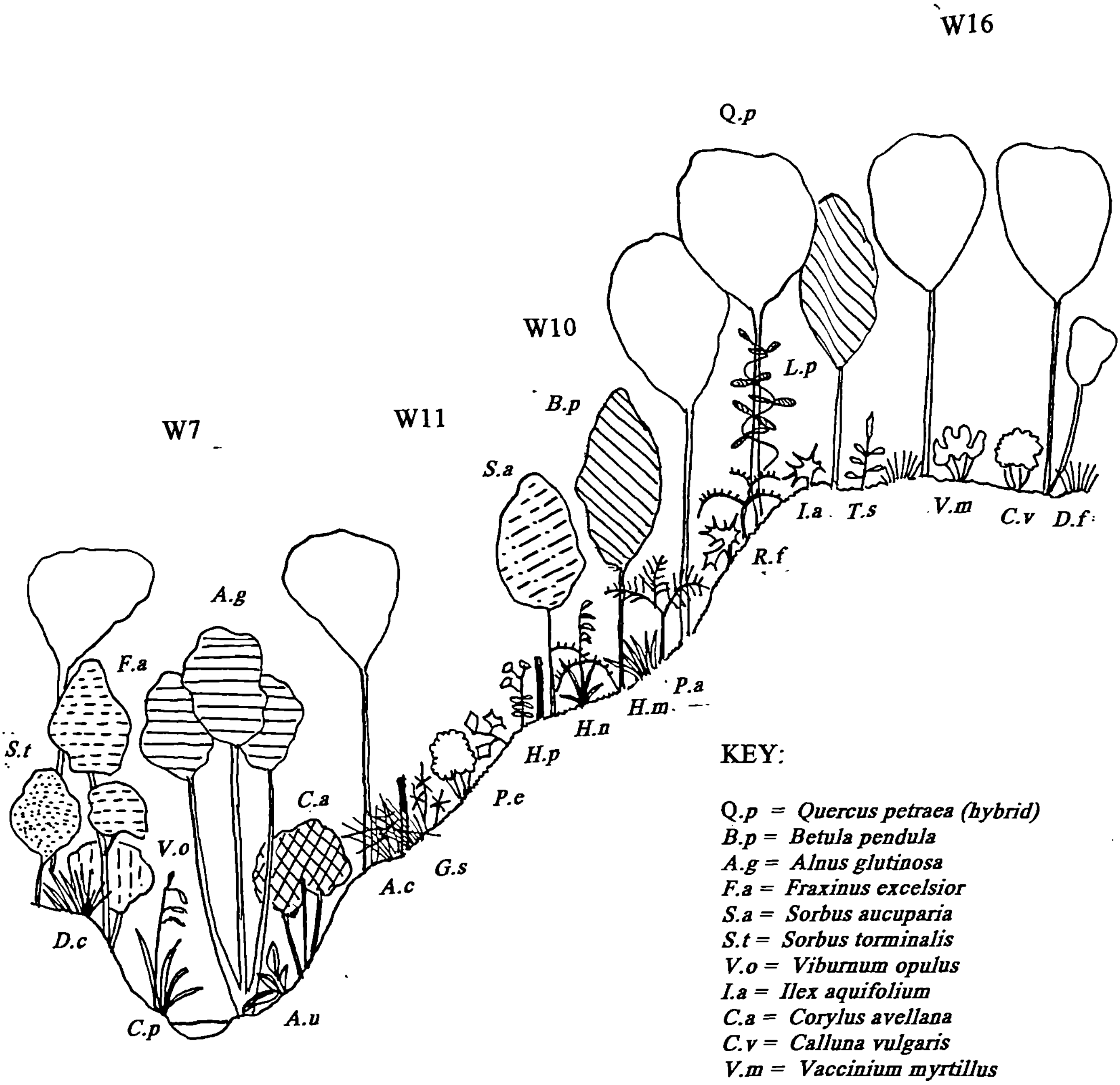
Division of the oak-alder woods in TWINSPAN Group 100

Two sites separated by more than a mile and both located on a small brook were identified in a small polythetic Group - 1000. Both sites had a young or relatively sparse canopy cover without alder, and were characterised by the following plants: *Agrostis capillaris, Angelica sylvatica, Carex remota, Cirsium palustre, Chrysosplenium oppositifolium, Galium aparine, Geranium robertianum, Dryopteris dilatata, Juncus effusus, Melica uniflora, Poa trivialis, Ranunculus repens, Rumex obtusifolius* and *Urtica dioica*. In contrast, the other sites in Group 1001 were typical of river-side, mature deep-shade oak-alder woodland supporting the following indicator species - *Allium ursinum, Alnus glutinosa, Anemone nemorosa, Cornus sanguinea, Deschampsia cespitosa, Holcus mollis, Hyacinthoides non-scripta, Lamiastrum galeobdolon, Mercurialis perennis* and *Oxalis acetosella.*

6.4 Summary

The findings of the phytosociological study made clear a distinction between two broadly contrasting plant communities, namely oak - birch stands on plateaux; and mixed broadleaved woodlands on lower slopes and in valleys. These results supported the conclusions of Salisbury's (1925) study of Wyre Forest. Subsequent divisions of the samples within these two broad categories identified clusters which exhibited weak affinities to various stands described in the NVC (FIGURE 6.4.1). However, the distinctive assemblages of species could not be described as typical examples of their respectively matched NVC stand-types. Furthermore, several species, in particular, *Quercus petraea, Pteridium aquilinum, Holcus mollis and Rubus fruticosus* agg., *Lonicera periclymenum* and *Viola riviniana,* persisted at a high frequency and level of abundance throughout the forest, accounting for a measurable degree of floristic grading between stands. A number of the smaller divisive groups in the TWINSPAN data identified clusters of sites which had experienced recent disturbance, mainly in the form of coppicing. These groups supported a high frequency of species more representative of open canopy woodland which is also subjected to the pressures of grazing. Consequently, these stands fell into the NVC classification category of a W11 *Quercus petraea-Betula pubescens-Oxalis acetosella* stand.

FIGURE 6.4.1 Forest stands and representative species



KEY:

Q.p = Quercus petraea (hybrid)
B.p = Betula pendula
A.g = Alnus glutinosa
F.a = Fraxinus excelsior
S.a = Sorbus aucuparia
S.t = Sorbus torminalis
V.o = Viburnum opulus
I.a = Ilex aquifolium
C.a = Corylus avellana
C.v = Calluna vulgaris
V.m = Vaccinium myrtillus
L.p = Lonicera periclymenum
P.a = Pteridium aquilinum
R.f = Rubus fruticosus
A.c = Agrostis capilaris
C.p = Carex pendula
D.c = Deschampsia cespitosa
D.f = Deschampsia flexuosa
H.m = Holcus mollis
T.s = Teucrium scorodonia
H.n = Hyacinthoides non-scripta
H.p = Hypericum pulchrum
P.e = Potentilla erecta
G.s = Galium saxatile
A.u = Allium ursinum

CHAPTER 7

AN INTERPRETATION OF THE VEGETATION ANALYSIS

7.1 INTRODUCTION

The vegetation analyses aimed to provide a detailed account of the various stand-types in Wyre Forest, and to classify these into meaningful communities. Records of the 109 quadrats of the TWINSPAN analysis were subsequently matched against the National Vegetation Classification communities described by Rodwell (1991). Use was also made of the TWINSPAN programme to examine species association patterns which might be interpreted in the context of environmental factors operating within Wyre.

7.2 THE HOMOGENEOUS STAND-TYPES

At its simplest, and on the basis of the widespread presence and high abundance of a number of characteristic species throughout the forest, Wyre can be described as a mixed oak woodland. This supports extensive patches of oak-heath woodland, riparian habitats consisting of alder-oak and oak-ash stands and a linear stand of recently established secondary woodland along the disused railway line on artificially base-rich soils. On the railway line the trees largely grew from self-seeds from adjacent ancient forest stands and consequently form maiden-growths with very few coppice stools. Finally, in these "new woods" the field layer is a mixture of ancient woodland species and plants more typical of secondary or pioneer forests.

The assemblage of species constants found throughout the oak woodland makes it difficult to classify this stand-type on the basis of NVC communities. This is also true for smaller guilds identified within oak and mixed broadleaved woodland (see results of MATCH analysis in Chapter 6). The reasons for the lack of clear attribution to NVC communities may relate to the very varied soil conditions, management and grazing pressure. Furthermore, with regard to regional patterns of vegetation, Wyre Forest is within the 'tension' zone between oceanic and continental systems. This may account for the particular assemblage of plants which often give rise to NVC W11 - type woodland. Species representative of this ecosystem include *Quercus petraea, Calluna vulgaris Deschampsia flexuosa, Holcus mollis, Potentilla erecta, Teucrium scorodonia* and *Vaccinium myrtillus.*

The TWINSPAN analysis splits the plateaux and valley samples which coincide with the distinctions made between oak woodlands and mixed broadleaved stands. Further analysis fails to make strong distinctions between sub-groups in the oak woodland samples. and consequently the NVC community assigned to these Groups are tenuous. In contrast, the TWINSPAN divisions in Group 1 representing the broadleaved stands are stronger and the resulting Groups can be classified with some assertion.

On the basis of the TWINSPAN analysis the vegetation of Wyre Forest can be classified as follows:

COMMUNITY:	SUB-COMMUNITY:
Transitional oak woodland: *Quercus petraea - Betula* spp. Stand.	*Rubus-Pteridium-Holcus mollis* *Deschampsia flexuosa-Vaccinium-Calluna* *Agrostis capilaris-Galium saxatile* *Melica uniflora-Viola riviniana*
Mixed broadleaved woodland: Alno-quercus stand	*Betula pubescens-Molinia caerulea* *Alnus glutinosus-Carex pendula* *Fraxinus-Corylus-Rubus fruticosus* agg.

7.3 THE ISA AND TWINSPAN ANALYSIS

The initial binary division of both TWINSPAN and the ISA classifications recognised two groups of woodland types in Wyre, that of the more base-rich soils, and at the opposite end of the spectrum woodland characteristic of brown earths of low base status or brown podzolic soils. This floristic division is recognised in the NVC (Rodwell 1991) as the primary distinction between mixed deciduous and oak-birch woodlands. However, there was considerable floristic grading between the mixed broadleaved valley woodlands and the oak-birch plateaux stands which in turn resulted in indistinct boundaries. The extent of continuous forest cover over a complex and varied geographical landscape has allowed for broad vegetation tension zones to develop between stand-types. Species which have contributed to this grading include *Holcus mollis, Lonicera periclymenum, Pteridium aquilinum, Rubus fruticosus* agg., *Teucrium scorodonia* and *Viola riviniana.* (FIGURE 7.3.1). Furthermore, the general status of the more vigorous species has been altered by intensive browsing by Fallow deer and also by a long history of management (see Chapter 5). Past silvicultural practices have also favoured the development of a more impoverished and uniform assemblage of canopy and shrub species (see Chapter 4). The complex interaction between primary and secondary environmental factors was reflected in the plant species assemblages. Within each of the recognised communities smaller guilds could be identified (TWINSPAN Groups 000, 0010, 011, 0101, 11) which were often associations of two or more locally dominant species. However, the occurrence of these often small guilds (FIGURE 7.3.2) throughout the community suggested that they were part of the homogeneous vegetation and not distinctive sub-communities. Consequently, attempts to interpret these stand-types using the NVC seemed to distort their representativeness and this was borne out by the results of the MATCH analysis. In view of these problems it was concluded that whilst *the NVC was a useful aid in the broad* description of this forest vegetation it was less effective in providing a framework for the finer details of the classification.

FIGURE 7.3.1 CONSTANCY VALUES FOR 12 SPECIES FOR FIVE WOODLAND STAND-TYPES, WYRE

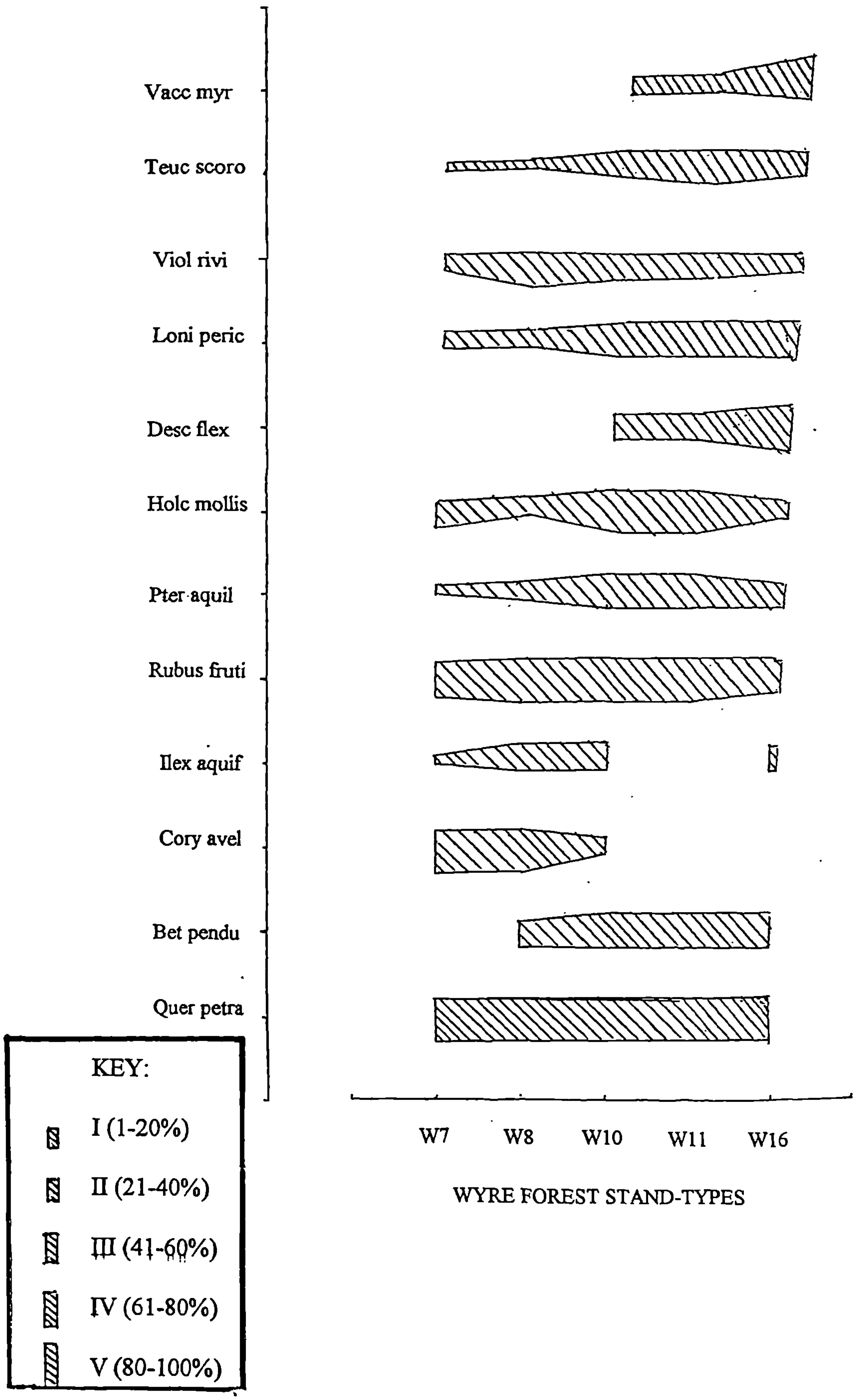
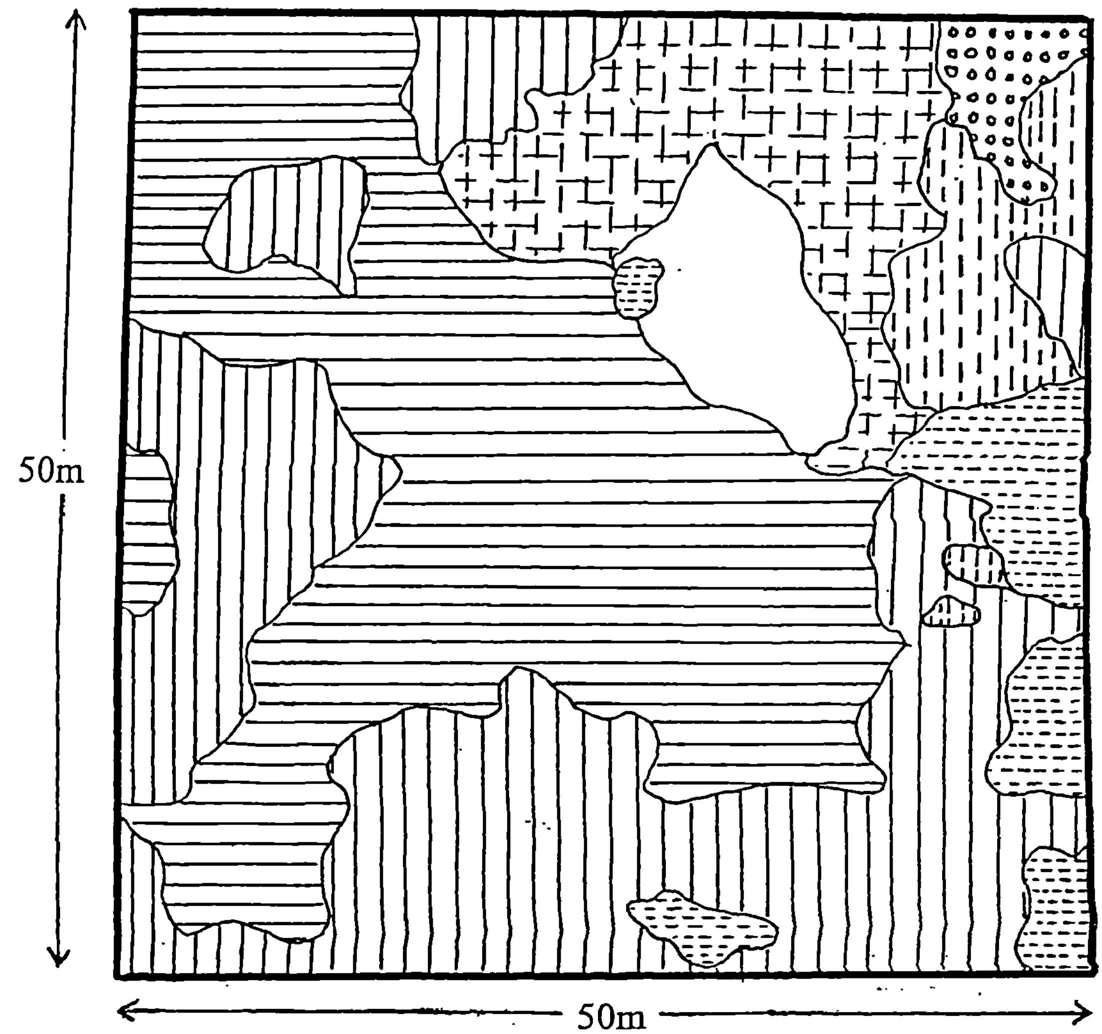


FIGURE 7.3.2 Example of vegetation patterns in a *Quercus-Pteridium aquilinum-Rubus fruticosus* stand-type, Wyre Forest



Holcus mollis-Pteridium aquilinum

Holcus mollis

Rubus fruticosus-Pteridium aquilinum

Rubus fruticosus-Holcus mollis

Rubus fruticosus-Vaccinium myrtillus-Pteridium aquilinum

Vaccinium myrtillus-Deschampsia flexuosa

Rubus fruticosus

Species are present in order of abundance:
Dominant>abundant>relatively less abundant

However, the TWINSPAN analysis provided a more objective interpretation of the sample data which made for clearer distinctions between the various vegetation types.

7.3.1 The calcifuge communities

The weak divisions within Group 0 (Oak woods) of the TWINSPAN analysis provided further evidence of the considerable floristic grading throughout the woodlands. The results of a MATCH analysis supported this view (TABLE 7.3.1.1). More than eleven percent of the samples in group 00 were identified as W11 *Quercus* spp.-*Betula pubescens-Oxalis acetosella*, and an equally large number of quadrats were recorded as W15 *Fagus sylvatica-Deschampsia flexuosa.* A possible explanation for the considerable variation in community-types may lie in the relationship between soil conditions and forest management.

TABLE 7.3.1.1 Results of the MATCH analysis for samples in the TWINSPAN group 00 (36 items in this group)

Running order in MATCH analysis	NVC stand types	Coefficient value	*Proportion of quadrats in each NVC category
First	W16	42.4	69%
Second	W15	36.5	11.5%
Third	W11	32.1	11.5%
Sub-communities	W16b W16a W17b W15d W15c	45.6 45.3 40.1	- - - 34.6% 31%

(remaining 8% were matched as W10)

- Represent the number of individually matched quadrats of highest coefficient values in each community.

Areas of raised ground - humps and ridge-tops revealed thin, heavily-leached soils (Penistan 1963) which supported only the hardiest of calcifuge plants. These sites were identified in one of the marginal TWINSPAN groups (0011) which had in common substantial areas of bare ground (average percentage of bare ground for the 22 quadrat samples in this group was 23.3%) and *Calluna vulgaris* as a preferential species. The high prevalence of *Calluna vulgaris, Galium saxatile* and *Teucrium scorodonia* combined with a decrease in crown cover of *Quercus petraea* had distanced this particular assemblage from the NVC W16 stand-type. These areas of poor soil generally supported smaller trees (see Chapter 5) with fluted canopies which were less shade-promoting. On damper soils the relatively thin canopy cover favoured sun-loving species which accounted for a number of the quadrats registering a stronger affinity with the NVC W11 *Quercus-Betula-Oxalis* stand-type (quadrats 186, 190, 193 are examples of recently coppiced sites successfully matched with NVC W11 stand-types). Furthermore, the MATCH prognosis pointed to higher constancy values than expected for a W16 woodland for *Holcus mollis, Lonicera periclymenum* and *Vaccinium myrtillus*, and higher quantity values than expected for *Holcus mollis, Ilex aquifolium* and *Luzula sylvatica* (TABLE 6.3.2.4, Group 001), all of which are more common in the NVC W11 stand-type (Rodwell 1991).

Deer browsing also played an important part in determining the composition of the oak woodland. This was apparent in exclosures fenced off from the deer. In coppice coupes cut since 1990, two years before the sampling was carried out birch and oak regeneration was significantly higher than in the surrounding woodland. (up to 40%). The present study suggests that there are three important environmental factors which favour an NVC W11 stand-type in Wyre: increased soil moisture, which sometimes increases on recently coppiced sites (Barkham 1992); higher light levels; and browsing pressure (Rodwell 1991). The prognosis for Group 001 had higher than expected constancy values for *Holcus mollis* and *Vaccinium myrtillus* compared to the NVC W16. Again, these two species are more typical of oak-birch woodland of moist but free-draining and base-poor soils in the cooler and wetter north-west of Britain. Grazing by stock or deer also contributes to the character of this type of woodland (Rodwell 1991). However, the MATCH analysis also registered a high coefficient value for NVC W15 *Fagus sylvatica-Deschampsia flexuosa* stand-type (TABLE 7.3.1.2)

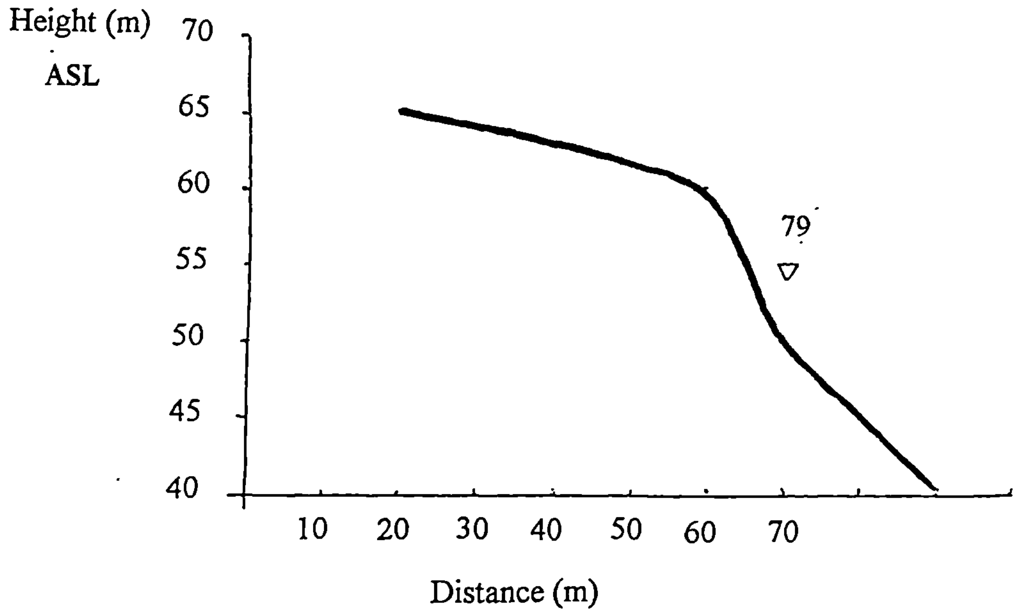
TABLE 7.3.1.2 MATCH coefficient values for TWINSPAN Group 001.

MATCHED NVC STAND-TYPE	COEFFICIENT VALUES
W16	52.8
W10	48.2
W15	43.1

A possible reason for this result lies in the conversion of coppice to high-forest oak over a period of 180 years which resulted in an unusually high density of trees (The average density of trees and coppice stools for oak woodland was 825 per hectare, excluding saplings smaller than 7 cm dbh). With these conditions prevailing the understorey and field layer had become impoverished with moderately shade-tolerant species such as *Deschampsia flexuosa, Ilex aquifolium* and *Vaccinium myrtillus* persisting. Similar shady conditions and field layer species are given for the NVC W15 stand-type (Rodwell 1991). Furthermore, the historical removal of non-commercial oak woodland tree species including birch, rowan, holly, wild service and yew (George 1987) would by simplification help to promote semblances towards a more beech-like wood.

Floristic grading was also apparent in other TWINSPAN group 0 divisions. Group 01 consisted of samples which were identified in the field as being representative of W10 stand-types on the basis of species present which were consistent with the NVC descriptions. Whilst the MATCH analysis of this group distinguished between W10 and W16 stand-types (coefficient values of 51.3 and 41 respectively) only small variances of the principal components (eigen values at each classification division seldom exceeded 0.2) were recorded at each division suggesting that the programme failed to identify clear community distinctions. However, the TWINSPAN data provided a clue as to the causes of the complex assemblage of species in group 01. Sites in Group 011 were all located on steep ravine slopes (FIGURE 7.3.1.1) probably having combined higher base-status with free-draining soils. Furthermore, the high proportion of intermediate sized stems in these stands suggested

FIGURE 7.3.1.1. Profile of quadrat sample 79 , TWINSPAN Group 011, Dowles valley, Wyre Forest



Much of the forest was thrown up into relief with plateaux falling away to deep valleys. In many cases the valley slopes were steep sided (as it was for site 79), and the combination of slope, soil and moisture would result in a particular type of vegetation. In the case of site 79 the movement of ground water through sandstone and shale favoured the growth of *Luzula sylvatica*.

that the trees had more recently been singled. Subsequently, a number of the samples were classified as W11 or W16 stand-types in a MATCH analysis. In Group 0101, the cluster of samples represented recently coppiced or disturbed woodland. The sparse canopy cover and higher soil moisture levels often associated with recently coppiced woodland (Barkham 1992) promoted a number of plant species more typical of the NVC W11 *Quercus-Betula-Oxalis* stand-type. This was born out in the MATCH analysis (TABLE 7.3.1.3 show all the individual match readings for 0101).

TABLE 7.3.1.3 MATCH values for the quadrat samples in Group 0101

Quadrat number	MATCH coeffient value
102	W11 28.9 W19 23.6
131	W11 23.4 W16 21
163	W11 25.8 W15 20
186	W23 20.5 W25 18.5
TOTAL MATCH	W11 - 36.1; W10 - 33.0

Old coppice stools or dead tree stumps created areas of low soil pH values (Oliver & Webster 1987). These raised mounds favoured strongly calcifuge species and the regular occurrence of these features in W10 *Quercus-Pteridium-Rubus* stands introduced species more commonly associated with the W16 *Quercus-Betula-Deschampsia flexuosa* woodland. Ultimately, there was a strong element of convergence between the two communities (a comparative test between these two forest stands using Sorensen's coefficient of similarity gave a value of 0.65). Furthermore, when the samples from TWINSPAN group 01 were analysed using MATCH (TABLE 7.3.1.4) the margin between the coefficient values for W10 and those of W16 was small.

TABLE 7.3.1.4 Results of the MATCH analysis for the samples in TWINSPAN group 01

NVC stand-type	MATCH Coefficient values	% of samples in each category	MATCH diagnosis
W10	51.3	48%	*H.mollis, T.scorodonia V.riviniana* - too high in samples
W16	41.0	36%	*H.mollis, L.periclymenum, T.scorodonia* -too high in samples
W11	38.4	12%	*A.capillaris, D.flexuosa, O.acetosella* -too low in samples

(the remaining 4% of the samples were affiliated to NVC W15 and W17 stand-types)

As for the TWINSPAN Group 00, the quadrat samples which were affiliated to the NVC W11 stand-type were on moister soils and showed evidence of either recent or past canopy disturbance. During the last 50 years the trees on these recently managed sites (represented by Group 011) had been felled and the coppice stools left to regenerate. Typically these areas had a high density of small regenerating birch saplings and a small number of large trees. The number of stems over 24 cm dbh was 17 out of 133 measured, as compared to 38 similar stems out of 116 measured for sites in the TWINSPAN Group 010. The difference between these two values was significant when they were compared using X^2 analysis; the calculated X^2 was 4, 1^0 freedom, 5% level, critical value = 3.84. Furthermore, the indicator species for group 011, which included *Agrostis capillaris, Deschampsia flexuosa, Galium saxatile, Luzula campestis, Luzula sylvatica* and *Teucrium* *scorodonia*, have low tolerance to shade (Grime et al. 1988). This contrasted with Group 010 which represented a cluster of sites more commonly associated with sandy-clays of flat plateau tops. These areas had rather less exposed ground (an average of 18% for a sample of 32 quadrats), and a higher proportion of species considered representative of the NVC W10 *Quercus-Pteridium-Rubus* stand-type, including *Holcus mollis* (average of 37% cover), *Pteridium aquilinum* and *Rubus fruticosus* agg.

The ISA study demonstrated that modern silvicultural practices have affected forest vegetation. The presence of *Holcus lanatus* and *Juncus effusus* in the ISA divisive Group 100 which represented samples taken from the Scots pine plantation, suggested the influence of past disturbance (these two species were absent from surrounding semi-natural woodland). *Holcus lanatus* is not uncommonly identified with young oak woodland or conifer plantations, in particular of *Pinus sylvestris* (Rodwell 1991). Modern silvicultural practices have a profound effect on forest vegetation as the level of disturbance is high in comparison to traditional systems of management. Practices such as thinning, extraction and planting have disrupted the soil profile in many of the forest plantations, often screefing (mechanical removal of vegetation and surface layer of the soil), and compacting the ground. Consequently disturbance-tolerant species such as *Holcus lanatus* and *Juncus effusus* have been favoured. Furthermore, the higher light flux in the mature pine and larch stands had encouraged the growth of more shade-intolerant herb species including *Galium saxatile* and *Potentilla erecta*.

7.3.2 Less acidophilous communities

The cluster of samples in group 1 of the TWINSPAN analysis represented both woodland mire and mixed broadleaved woodland. The primary factors influencing these two communities were the moderately high base status of the soil, and moisture. Virtually all these woodland sites were located on steep valley slopes or along river edges where nutrient seepage collected from higher ground (Salisbury 1925; Packham 1975: Table 5.3). Consequently, these more base-rich sites, whether wet or dry, supported a less acidophilous community. It was apparent from both the ordination and MATCH analysis indicate that there was considerable convergence of the woodland mire and mixed broadleaved woodlands and also with a third woodland community NVC, W10- *Quercus-Pteridium-Rubus* stand-type.

The woodland mires represented in group 11 were identified in the field as *Betula-Molinia* and yet the MATCH analysis failed to make any firm distinction between this community and the *Alnus-Fraxinus-Lysimachia* stand-type. This affinity to Alnion glutinosae woodland is also recognised in the NVC (Rodwell 1991). Stands of *Betula-Molinia* in Wyre were often associated with spring issues from exposed shale outcrops, or on steep slopes where slumping had resulted in clay over-lying sandstone which suggested a damp but base-poor soil. However, recent planting programmes had separated these birch stands from the riparian woodlands.

There appeared to be some relationship between wetland sites sampled in the ISA study and the woodland mire communities identified in the TWINSPAN analysis. A measure of this affinity using Sorensen's coefficient of similarity indicated a low (0.37) similarity. The flushes surveyed for the ISA study lacked any tree cover and have been kept open for at least five years. This has allowed for a greater diversity of fugitive species. Consequently, these sites resembled natural mires more closely.

The mixed broadleaf stands included in the TWINSPAN Group 10 constituted much of the valley and riparian woodlands. Subsequent division of this group revealed the two communities identified in the field - the *Fraxinus-Acer-Mercurialis* community; and the *Alnus-Fraxinus-Lysimachia* stand-type. However, as for the oak woodlands, there was a large degree of floristic grading between communities as demonstrated in the MATCH analysis (TABLE 7.3.2.1). Much of the grading between the different stand-types occurred along the Dowles

TABLE 7.3.2.1 Results of the MATCH analysis for two TWINSPAN Groups 100 and 101.

TWINSPAN GROUP:	NVC COMMUNITY:	MATCH COEFFICIENT:
100	NVC W7 stand	55.4
	NVC W10 stand	49.9
	NVC W8 stand	46.8
101	NVC W10 stand	55.8
	NVC W8 stand	54.8
	NVC W12 stand	48.3

Brook and its tributaries whilst the secondary woodland along the railway line maintained a more distinctive community. The underlying soils to these riparian woodlands were primarily alluvium (Penistan 1963) although there was considerable variation in the proportion of clay to sand. This in turn led to the development of both free-draining berms and waterlogged mire sites. The drier areas encouraged the growth of *Quercus-Corylus* stands whilst the waterlogged grounds were favourable sites for Alnion glutinosae woodland. With both mixed broadleaved stand-types occupying a narrow habitat within the forest floristic grading seemed almost inevitable.

Management also played an important part in promoting floristic grading between communities. For instance substantial quantities of ash *(Fraxinus excelsior)* had been removed from the forest during the last war which may account for the low coefficient value for *Fraxinus-Acer-Mercurialis* in the MATCH analysis for the TWINSPAN Group 101. Furthermore, oak was selectively favoured on valley sites as a commercial tree by early foresters thus enhancing the features of a *Quercus-Pteridium-Rubus* woodland. Another important factor contributing to the distinctive composition of the mixed broadleaved woodlands was deer grazing pressure. The MATCH analysis for Group 101 showed a community fit against *Fraxinus-Sorbus-Mercurialis* for 60% of the 12 quadrat samples. The NVC description for this stand-type identifies permanent moist soils and grazing pressure as the two principal components responsible for the characteristic assemblage of species (Rodwell 1991). Furthermore, *Viola riviniana*, noticeable by its high frequency in this vegetation, is favoured in woodlands which are intensively grazed (Rodwell 1991; Ratcliffe 1992). The MATCH results also included suggestions of a *Fagus-Mercurialis* community which did not occur in Wyre. However, conditions on the disused railway line may be analogous to those of beech woodlands in that a combination of a sparsely vegetated dry-wood community on base-rich substrate with a high abundance of *Rubus fruticosus* may have tended to produce a *Fagus-Mercurialis*-like stand. Despite the presence of ancient woodland indicators in the recently developed secondary woodland along the disused railway the samples representing this community were clearly distinguished from other ash stands in the forest. The raised railway escarpment, built from a combination of limestone chippings and slag, created conditions which were characteristically base-rich and free-draining unlike the remaining ash stands alongside the alder woods.

As with the *Fraxinus-Acer-Mercurialis* woodland the Alnion glutinosae stands graded with the *Quercus-Pteridium-Rubus* community, so much so that these alder woodlands had a characteristic vegetation of their own. Furthermore, variation within the stand was common and where *Deschampsia cespitosa* grew in abundance under *Corylus avellana* the Alnion glutinosae woodland supported a floristic assemblage more akin to the W8 *Fraxinus-Deschampsia cespitosa* sub-community. The combination of *Alnus* and *Allium*, whilst common along Midland streams, was not clearly identified in the NVC descriptions on woodlands. Rather, the NVC refered to *Allium ursinum* under *Corylus avellana* in a W8 *Fraxinus-Allium* sub-community. The removal of substantial quantities of *Fraxinus* during the last war may have promoted the development of a *Querco*-Alnion community where previously ash and other less shade tolerant species may have led to a different interpretation of the vegetation-type.

The interpretation of the Alnion glutinosae vegetation was further complicated by the distinctive cluster of samples in group 1000 which represented two separate sites on deep-sided springlines.

Despite the results of the MATCH analysis (TABLE 7.3.2.2), which confirmed an affiliation to *Alnus-Fraxinus-Lysimachia* stand-type, *Alnus glutinosa* and *Corylus avellana* were absent from the canopy and understorey.

TABLE 7.3.2.2 MATCH values for two TWINSPAN Groups 1000 and 1001.

TWINSPAN GROUP:	NVC STAND-TYPE:	MATCH COEFFICIENT:
1000	W7 *Alnus-Fraxinus*	28.3
	W6 *Alnus-Urtica*	22.4
	W10 *Quercus*	17.8
1001	W7 *Alnus-Fraxinus*	55.4
	W10 *Quercus*	49.9
	W8 *Fraxinus*	46.8

The stands could best be described as an oak-birch woodland with a field layer similar to that of the NVC W7 stand. It is uncertain what factors contributed to this distinctive community although the proximity of an NVC W16 community would suggest the prevalence of base-poor soil conditions in the area unlike the typical riparian woodland of Dowles Brook. In the latter case, deep alluvial deposits punctuated by flushes of heavy clay favoured vegetation more typical of Alnion glutinosae stands which were clearly represented in the TWINSPAN Group 1001.

7.4 SUMMARY

The vegetation of Wyre forest falls into two broadly defined categories: the oak woods of plateaux and hill slopes; and the mixed broadleaved woods of valleys and mires. However, these two categories are distinctly heterogeneous with several recognisable species assemblages. There is considerable convergence between these various stand-types as a result of the wide distribution of several prominent species. Consequently some of the TWINSPAN Groups are not closely identifiable with NVC woodland communities.
The greatest contributory factor to the floristic variation in Wyre Forest is undoubtedly the edaphic conditions. Whilst the spatial

variation of soils across the forest is very complex, three master factors - pH, soil nutrients and water regime were primarily responsible for the broad distinction between plateau and valley sites. Consequently the forest vegetation could be crudely classified on the basis of the local lithology into the oak-birch woodlands of the high ground and the mixed broadleaved stand-types of the valleys. However, this distinction was considerably diluted by the sharing of many common species. Within this binary division the five main stand-types identified (W10; W16; W7; W8 and W4) were recognized in the descriptions of the NVC woodland communities (Rodwell 1991) although precise matching of the forest communities with relevant NVC stand-types proved difficult. The strong continuity patterns between the various stand-types results from the primary physical factors influencing the forest system, namely, the complex spatial variation of soils; the juxtaposition of these communities without a real geographical break in forest cover; deer grazing pressures and finally the impact of past management practices, either directly or indirectly.

On the strength of these results there is a strong case for suggesting that Wyre may be classified as a single complex community - a transitional oak forest community identified by a distinct association of species which include *Quercus* and *Betula* hybrids, *Ilex aquifolium, Corylus avellana, Rubus fruticosus* agg., *Holcus mollis, Lonicera periclymenum, Pteridium aquilinum, Viola riviniana* and *Hyacinthoides non-scripta.* Substantial changes in soil conditions alter the proportional representation of both constant and associated species to a large enough degree that five sub-communities or stand-types may be recognised. These five sub-communities show strong affinities to five NVC stands:

W4 *Betula pubescens-Molinia caerulea* stand;
W7 *Alnus glutinosa-Fraxinus excelsior-Lysimachia nemorum* stand;
W8 *Fraxinus excelsior-Acer campestre-Mercurialis perennis* stand;
W10 *Quercus robur-Pteridium aquilinum-Rubus fruticosus* stand; and
W16 *Quercus spp.-Betula spp.-Deschampsia flexuosa* stand

The degree to which these sub-communities grade floristically into one another suggests that they may not be distinct enough to be awarded community status. Large blocks of relatively undisturbed woodland promote greater continuity between stand-types. Where disturbance occurs as a result of management the vegetation changes substantially to produce noticeable patches in the forest. Often where the soil is moist, stands of either W10 or W16 which are in early post-clearance successional stages of development, undergo change and are more affiliated to a W11 *Quercus petraea-Betula pubescens-Oxalis acetosella* community. This is more apparent in intermediate successional stands subjected to deer browsing pressure. These successional communities may persist for several decades as in the case of the railway line and small fells cut during the last war. Past management has affected the forest in other ways by changing the proportion of species in the canopy and understory. These vegetation patterns brought about by former management practices appear important in shaping the nature of the forest. Finally, the impact of deer browsing on the field layer community, and more strikingly on the tree and shrub layer, has been profound. In the absence of browsing pressure the abundance of dominant species relative to others is altered. The performance of woody perennials is enhanced when released from the pressures of browsing. Consequently, the density of vegetation and degree of vertical cover is considerably greater in protected exclosures.

CHAPTER 8

STUDY REVIEW AND A CONSERVATION STRATEGY FOR WYRE FOREST

8.1 Study Review

An important feature of this study, as identified by its objectives, was its broad scope from historical to ecological. The scale of the site and the emphasis on phytosociology and forest structure lent itself to a survey-based rather than an experimental-type investigation. Although some aspects were little studied, it was considered best to concentrate effort on investigative fieldwork to provide as full an account as possible on forest history, vegetation communities and features important in conservation.

8.1.1 The historical study

The lack of substantial documented evidence prompted the use of verbal accounts and the development of woodland interpretation fieldwork. Taped conversations with a retired local forest worker provided considerably more detail about traditional forest management practices in Wyre over the last hundred years than any written record. Furthermore, these accounts explained local trends and features not recorded elsewhere in scripts. Oral history put more emphasis on social and economic detail than on scientific data. This contrasts with contemporary records on forestry practice which include information such as tree species and age; stocking density and management; and yield of crop. The field-based studies on forest structure were devised to enable the interpretation of the forest landscape in a historical context. They proved very useful in determining the extent and pattern of recent human impact on the forest. The findings also demonstrated that Wyre Forest was more varied in structure than indicated in other publications (Nature Conservancy Council 1989). The techniques used here however, may be criticised. The representative sampling employed would have incorporated an element of bias into the results whereas random scattering of quadrats would have ensured that there were no selective pressures in the choice of sites. However, representative sampling was adopted so that all structural stand-types were considered. Given the size of the forest and the small area occupied by some of the stand-types it was very likely that some would not have been recorded under random sampling. The small size of some stands also made it difficult to be consistent in the number of quadrats recorded, the largest number being recorded in the biggest stands. Another disadvantage of this technique was its limited use in extending the boundaries of archaeological interpretation beyond a period of marked change in forestry management. For instance, the heavy extraction and extensive felling of timber during WW2 completely disrupted any traditional form of management and transformed the character of the woodlands. A structural survey of the forest provides a good description of post-war forestry but gives little idea of what management practices earlier. Thus forest treatment during WW2 forms a major baseline for the forest structure analysis.

The analysis of data on forest structure using TWINSPAN was effective in demonstrating the existence of distinctive stand-types. More information could have been extracted from the forest structure survey had the records included basal area data. Also, a measure of proximity between trees would have been helpful in measuring the impact of human intervention on the forest structure. Here the use of plotless methods, e.g., nearest neighbour sampling, to measure forest structural variables might have been a useful strategy.

8.1.2 The phytosociological study

A principal problem in this study was limitation of time. For an effective survey of the vegetation, the forest areas would require at least two visits to record both vernal and summer communities. However, the survey made the optimal use of time. Despite attempts to map plant communities within Wyre Forest the more detailed study (NVC, Chapter 6) showed that homogeneous stand-types could, in many instances, not be distinguished easily as they were obscured by micro-scale patterns of change in the vegetation. This was further complicated by the fairly uniform composition of the canopy cover. Whilst MATCH analysis was used to help classify homogeneous stand-types the weak coefficient values illustrated the problems of recognizing distinct communities. This made for difficulties in applying the National Vegetation Classification method of survey especially as the present records are based on representative sampling. This problem is recognized by Hill (1979) and Causton (1988) who recommend that the most effective way of surveying plant communities is to use random sampling technique. Subsequent analysis of the results by ordination or other statistical procedures are then less likely to be affected by bias.

Another aspect of the forest vegetation which was not shown by the phytosociological investigation but was very apparent in the field was the change in species composition across environmental gradients. The combination of complex soil patterns and landscape relief was reflected in the vegetation; the *most effective way of* recording this is to use transects with contiguous stands.

Some records from the sampled 4m x 4m stands did not readily conform with the NVC categories of Rodwell (1991), which now afford a national basis for vegetation studies. Moreover, vegetation boundaries were often diffuse.

8.2 A CONSERVATION STRATEGY FOR WYRE FOREST

The unique nature of Wyre Forest can be attributed to several factors, including regional climatic patterns; the wide variation in soils; and the impact of grazing from roaming herds of deer. Furthermore, over the last fifteen hundred years the impact of continual and changing management practices has altered the character of the forest from its primeval state. In essence these changes have been in increasing silvicultural refinement in which the structure and composition of the forest have been directed towards more homogeneous commercial stand-types. In the latter stages of this development wholesale clearing of coppice and replanting with exotic commercial species to replace the less marketable oak and birch has resulted in over half of the forest losing much of its original character.

These changes are typical of the events which have taken place in many of the ancient semi-natural woodlands of Great Britain. Of the two million hectares of woodland in Britain only 300,000 hectares can be described as ancient, semi-natural,the rest having been replanted at some stage (Kirby et al. 1984). Over the last millennium there have been major changes in the forested landscape in Britain, particularly since the start of the twentieth century. In the last 90 years one of the major changes was the conversion of 84 km^2 of semi-natural woodland to plantation (Peterken & Allison 1989), and the reduction of coppice wood either through clearance or progression to high forest. It is estimated that 30-50% of the ancient semi-natural woodland that existed in 1945 has since been either cleared or changed to plantations. The quantities of individual trees have also considerably altered over time. Since 1947 there has been a net loss of 70-80 kha of oak in England whilst sycamore, ash and birch have substantially increased (Peterken & Allison 1989). The proportion of mature oak stands has been reduced: high forest stands over 80 years old have decreased from 47% of all broadleaf stands in 1924, through 49% in 1947, to 33% in 1980 (Peterken & Allison 1989). The rate of loss of ancient semi-natural woodland was greatest before 1902 and after 1978 (Barfield 1984), and post-war loss was between 30-50% (Peterken & Allison 1989). The great majority of plantations on ancient woodland sites have been established since 1930.

Concern for the future of the remaining ancient semi-natural woodlands has been voiced since the early 1950s but not tackled effectively until 1980 when a report on forestry by Sherfield (Peterken & Alison 1989) recommended separate measures to conserve the remaining ancient woodlands. These proposals were modified by the Nature Conservancy Council and presented in a paper (Steele and Peterken 1982) which recommended that existing ancient woods should be managed using native tree species in ways which maintain their value for nature and landscape conservation. Traditional or near-traditional systems should be favoured wherever possible (Kirby et al 1984).

These recommendations have formed the basis for the conservation management of most of the ancient semi-natural woodlands scheduled as Sites of Special Scientific Interest or National Nature Reserves. Consequently in the last fifteen years traditional management of woodlands has been vigorously promoted on both the practical and academic front (Peterken 1981, Rackham 1986, Fuller 1982, Packham et al 1992, Fuller and Warren 1995). The arguments in support of this strategy are that a long history of management has adversely changed "natural" woods and the remaining remnants have been intensively managed since the Middle Ages for timber, firewood, pasture, game etc. Consequently these habitat fragments have been modified to the extent that the woodland fauna and flora communities are often impoverished and dominated by more robust or adaptable species (Hambler and Speight 1995a). Many of the key species (those having a major influence in controlling community composition and diversity) and specialist species have been lost from the British landscape and the remaining wildlife often exists in artificially maintained conditions or numbers. To preserve what remains of the natural habitat requires intensive management. Under this pretext, species and habitat preservation is seen as a means of keeping a situation on "hold" until a time when a better conservation strategy is adopted (Kirby and Rush 1994). This policy is understandable for fragmented habitats which support small metapopulations of plant and animal species and take on the characteristics of island habitats (Begon et al. 1990). To prevent local extinctions of species demands increasingly more refined intervention management.

Recently this philosophy has been challenged and the practice of coppicing trees to conserve woodlands openly criticised by Hambler and Speight (1995a), who consider that a better understanding of conservation science and the application of some of its principles will ensure a more ecologically sympathetic system of management. Whilst a number of prominent conservationists are giving serious consideration to these views, the general trend amongst the conservation practitioners is to demonstrate a long-term commitment to coppicing in ancient semi-natural woodland. This is certainly the case for Wyre Forest. Wyre is an important conservation site for many reasons, one of which is the extent of unbroken forest which still remains (a rare feature in a landscape of severely diminished and fragmented woodland). Furthermore, it has, despite its turbulent history (Chapter 4), retained much of its ecological interest (Nature Conservancy Council 1989). Its large size earns it the status of a forest ecosystem capable of supporting large populations of key species as well as numerous phytosociological associations. Finally, the geographical position of the forest near the climatic boundary between the oceanic and continental regions of Britain promotes plant communities of the cooler, wetter west, as well as those of the drier, warmer south-eastern region of Britain (Sinker et al. 1985). Consequently, a rich assemblage of plants are found in the forest with an unusual floristic grading of communities (Chapters 6 & 7). These attributes have long been appreciated by both ecologists and conservationists and their importance acknowledged by the declaration of substantial areas of the forest as National Nature Reserve or SSSI.

Since 1988 English Nature has undertaken an ambitious programme of coppice management. The management plan produced for the Wyre Forest reserve (Nature Conservancy Council 1989) details the standard format *for good woodland conservation practice. The plan* advocates habitat diversity through the management of glades, rides, open wetland flushes, high forest and short-cycle coppicing, non-intervention, and coppice-with-standards. It interprets diversity to mean a varied range of management which in turn provides the desired structural diversity. It also targets specific plant and animal groups in its operational objectives. Ultimately, the prescription of traditional woodland practices is seen as the mainstay to woodland conservation. However, it does not prescribe a system of management historically practised in Wyre but a "text-book" version of coppice-with-standards. In practical terms the plan translates as felling two one-hectare coppice plots each year and in each case the felled coupe is fenced off using 2m high deer-proofing wire. In addition to the coppice programme ride-widening has been developed along well defined routes and linear features. To some extent there has been collaboration with Forestry Enterprise which have executed much of the work to promote a more holistic approach to conservation. Consequently wildlife corridors have been developed in the forestry section of Wyre.

A major rationale behind this management plan is the preservation of both the vernal plant communities and the butterflies of the forest, in particular the three species of fritillary. Butterfly populations have been monitored by English Nature since the beginning of the coppicing programme and the results suggest limited success. Colonisation of felled coupes by Pearl bordered Fritillary (*Boloria euphrosyne*) has been good although there is little evidence to suggest that population numbers on existing clearings have increased; rather, numbers have fluctuated considerably on these sites. With other animals there is a similar pattern of modest or poor response to coppice management. A long-term study on the adder (*Vipera berus*) (Sheldon 1995) in Wyre has indicated a progressive *decline in numbers matched by a poor* colonisation rate of recently cleared forest sites (Sheldon and Bradley 1995, unpublished). However, it is difficult to assess the success of the forest management plan without a more comprehensive wildlife monitoring programme. Equally, it is difficult to evaluate the importance of coppicing to the conservation of Wyre without considering those species which more accurately reflect the biodiversity interest of the forest. Whilst the species noted in the management plan are perceived as having high intrinsic appeal, their use as biodiversity indicators is limited. More interest should be afforded to dead wood species; leaf litter communities; or specialist groups such as Hymenoptera, Coleoptera, and invertebrates generally (Hambler and Speight 1995a).

Wyre forest contains one of the finest examples of continuous oak woodland in Britain (Nature Conservancy Council 1989). However, It has already lost most of its key species including Wolf, Boar, White cattle, Red squirrel, Red deer and Pole cat (Hickin 1971) and through centuries of intensive management its biodiversity has also diminished. More than 80% (Chapter 4) of all trees within the oakwood area are oak and less than 1% of these are larger than 60 cm dbh; even less of the woody component exists as dead standing wood - a principal factor in promoting biodiversity within a woodland (Hambler and Speight 1995a). The forest has also been severely disturbed and fragmented through both traditional and modern silvicultural practices. The introduction of plantation compartments has greatly increased the edge effect, which has been further compounded by the revival of glades, meadows and coppice plots within the forest. Certain opportunistic species have benefitted from these changes including *Pteridium aquilinum* (George 1987); Fallow deer which have had a severe impact on the vegetation; and *Kermes quercus* and *Sphyropsis* which have both devastated the oak throughout the forest. A number of remaining key species including the Adder (*Vipera berus*), Pearl bordered Fritillary (*Boloria euphrosyne*), High brown Fritillary and Hazel dormouse have progressively declined.

Other considerations need to be made relating to existing conservation management strategies. If a long-term commitment to coppicing is to be made the feasibility of sustaining this system in the face of market constraints is questioned. The current standing sales of oak are good whilst high forest is being brought back to coppice, but once a coppice crop is established the demand for small round wood is not likely to keep up with the required annual cutting programme.

As conservation adopts an increasingly refined scientific approach to management there is a need to change the emphasis in the evaluation scheme towards greater continuity of ecosystem processes; higher biodiversity; and less disruption. Furthermore, the feasibility of maintaining artificial systems in the long-term must also be addressed in the context of the current economic climate. With these points in mind a conservation strategy for Wyre must be developed and implemented which takes a holistic perspective of the forest and does not fragment this ecosystem. For Wyre this will require a radical re-appraisal of the management systems currently practised, and a fresh evaluation of the ecological and conservation interests. At present wildlife habitats are evaluated using the criteria of Ratcliffe (1977) for the assessment of SSSIs and Nature Reserves. Whilst this evaluation is potentially very powerful, its subjectivity opens it up to broad interpretation and often this takes the course of emulating traditional management and promoting "patchwork habitats". In the next stage of a conservation strategy a detailed management prescription is proposed for that site which often advocates reinstating traditional practices with appropriate modifications to provide for "special groups" or single species (Hambler and Speight 1995a). The differences in objectives between cultural and biological conservation are fundamental and whilst this view is largely accepted by conservation scientists, and has been publicised recently (Hambler and Speight 1995a), it has had little influence on the actions of the conservation practitioners. Whilst the traditional management approach to conservation is well advanced in Britain, other countries have adopted a more applied ecological approach to their conservation philosophy, a strategy put to good effect in America (Brewer 1994).

More recently conservation evaluation has been enhanced by the development of a phytosociological classification system, the National Vegetation Classification (NVC) for Britain (Rodwell 1991). The NVC is seen as a useful guide and model on which to base the conservation management of communities. However, it has sometimes been misused, and often in combination with the application of traditional management practices it has been incorporated into key site management aims and objectives. At worst, this has led to prescriptions no better than habitat management packages. In a sense, a specific habitat can be managed according to pre-conceived objectives and prescriptions to achieve the desired conservation state. This concept is almost as far removed from applied ecology as is cultural conservation. As seen in Wyre, NVC stands do not always cover the full representation of the vegetation.

A set of ideal objectives is required to ensure a more cohesive management of the forest to promote the following aims:
To ensure long-term ecosystem stability;
To promote and preserve biodiversity;
To ensure ecological continuity and uninterrupted forestry dynamics;
To safeguard the local ecological integrity of the site;
To maintain the cultural interest of the forest without detracting from the ecological objectives;
To develop "habitat networking" with the surrounding landscape;
To build into the conservation strategy an economic basis;
To fulfil reasonable recreational obligations to the public.

A long-term management plan to enact the stated objectives requires a three-stage approach as follows: a detailed baseline survey of the forest;
an ecological evaluation of the forest's attributes;
and finally, a management prescription to meet the prescribed objectives.

8.2.2 A baseline survey for Wyre

An ecological survey should aim to provide information about the structure, composition, and biodiversity of an ecosystem.

8.2.2.1 Forest structure survey

The structure of a forest is important in the promotion of spatial heterogeneity as this in turn increases niche packing and biodiversity (Brewer 1994). A survey of the forest structure may suitably be carried out using methods fairly similar to those employed in the present study. Large (200 m^2) randomly-spaced quadrats across the forest are desirably sampled. Measurements of the dimensions of all the woody components should be recorded. Additional records should include standing and lying dead wood, hanging trees and root plates, and crown cover of both canopy and understory layers. A measure of the field layer cover should also be made using 4m x 4m quadrats. Point quadrats can also be used at these random sites to determine the spatial heterogeneity of the vegetation using an index analysis method (Bibby et al. 1992). Furthermore, the density of vegetation (vertical cover) can be assessed using the density index Bibby et al. 1992)

8.2.2.2 Composition of the forest

Vegetation survey

The vegetation survey would appropriately take the form of three studies (see Chapter 5 and 6). In the first instance a Phase II survey would provide a vegetation map of the forest (Chapter 5) indicating the dominant plants in each stand. In the second study, using the mapping information, an NVC analysis (Chapter 6) would be carried out to give an indication of the range of stand-types. Finally, a transect studies of the tension zones between these stand-types and structurally stratified stands would provide information on the measure of continuity between apparently different vegetation-types.

Faunal surveys

Faunal surveys should, if possible, include all the main groups of invertebrates and vertebrates within recognized functional types. The most effective way is to stratify the forest into habitats and employ standard survey techniques. The survey of invertebrates should include the following functional groups:

Air-born pollinators: Lepidoptera; Hymenoptera and Diptera.
Phytophagus invertebrates: Coleoptera; Hemiptera.
"macro-shredders" - Detritus feeders: (including dead wood species).
Secondary and tertiary predators - arboreal and ground.

The survey of vertebrates should include Herpetofauna, birds and mammals.

Biodiversity study

Consideration of biodiversity is essential to understanding the ecological and conservation importance of an ecosystem (Hambler and Speight 1995a). To measure biodiversity for its conservation value would require a comprehensive survey of all living organisms. However, a more realistic approach is to measure quality biodiversity (Hambler and Speight 1995). This would involve targetting species or species groups at various trophic levels (functional types) within recognisable communities. The analysis would include the use of diversity indices (Brewer 1994).

Site assessment

Finally within the surveys section a site assessment should be carried out on other ecological features, bearing directly or indirectly on the flora or fauna, e.g. geomorphology, soils, current management; recreational and educational use.

8.2.3 Evaluation

Ratcliffe's (1977) criteria serve as a good starting point for an evaluation of the forest although there is a need to agree on the relative importance of these variables.

SIZE:
Several woodland evaluation schemes (Rackham 1986, Kirby et al.1984) fix a scoring system to their criteria and for the size category scores are set against different size groups. However, both the optimum and minimum size of a preserve should be linked to key species (Brewer 1994). The optimum size of a forest may be appropriately defined as the ability of that habitat to sustain a viable genetic population of a top trophic keystone species indefinitely. A measure of population viability can then be used to determine the ranking score for forest size.

DIVERSITY:
Often this criterion is interpreted to mean the range or density of habitats within a given area, and the number of species within desired groups, e.g., flowering plants, butterflies and birds. Rarely is it used to indicate the relative abundance of each species of a community; trophic complexity; or community structure. Equally ecological heterogeneity is seldom assessed in this context and yet it is a useful indication of potential niches. For example, the proportion of standing dead to live wood, or the proportion of root plates and lying/hanging timber to live trees can be used as a measure of diversity. A scoring system could also be used where the benchmark is given as the proportional representation of these features in a primaeval forest. Diversity indices should play an important part in measuring diversity.

RARITY:
It is important to conserve rare species as often they are keystone mutualists with an important role in the food web of a forest (Begon et al. 1990). An example in Wyre is *Euphorbia amygdaloides*,

a plant which plays an important part in the foodweb of several invertebrates, in particular the wood ant. All species, common or rare, play a vital part in the long-term stability of an ecosystem (Pimm 1994 - Rivet theory). However, as an evaluation criterion, rarity of any given species should be measured against its natural status within an ecosystem and conservation management should not be used to extend populations beyond their natural boundaries.

TYPICALNESS:
Most often typicalness is used to express the representativeness of a site to both the perceived phytosociological pattern of that region, and to a semi-natural landscape derived from historical management practices. Typicalness should further be used to define the ecological state of a woodland in terms of its structure and successional stage. Community composition is an important feature and should not be assessed against perceived phytosociological patterns derived from surveys carried out in other historically affected woodlands. Species constants and associates within neglected woodlands are represented in different proportions from those of worked coppiced woodlands and would provide a more natural basis for assessing typicalness.

NATURALNESS:
Naturalness is often perceived as the degree of resemblance of a habitat to a desired semi-natural state. However, this may not be an effective evaluation of the ecological status of a forest. Naturalness should be evaluated on the strength of a habitat's "natural" features which may include successional patterns; uninterupted dynamics; and habitat structure - both spatial, temporal and trophic. All these features can be assessed (Hambler and Speight 1995a) and so provide a useful measure against which habitats can be compared. For example the proportion of dead wood in natural woodland (Hambler and Speight 1995a); patch size and dynamics (Buckley 1992); trophic status (Brewer 1994); successional role species (Shugart 1984); and species diversity are all valuable measures of naturalness.

8.2.4 Impact assessment

Impact assessment is one of the more important issues concerning the conservation of Wyre forest as management has greatly influenced its ecology over the last 600 years. The division of the forest into compartments has produced a distinctive forest-interior edge effect, and in addition modern forestry management practices and the development of countryside recreation have resulted in greater disturbance and increased fragmentation. As a result of these factors certain animal species including Fallow deer, Woodcock and Goshawk have been displaced to quieter areas of the forest (Bradley 1996). The effects of coniferisation are also evident. Areas of mature conifer, or second rotation plantation have an impoverished vernal community (Hobson 1992). Often, recently thinned or cleared sites develop a ruderal community composed of more predictable species including foxglove, bracken, bramble or rosebay willowherb. Afforestation of Wyre has resulted in the creation of extensive areas of inhospitable forest with many animals including the Adder (Vipera berus) experiencing changes in population distribution. Certain habitat creation programmes including the establishment of "scallops" and rides have also contributed to the edge effect. Whilst seen as ecologically advantageous at the time it is now understood that this form of management promotes forest fragmentation and may increase the level of predation of both flora and fauna (Brewer 1994).

8.2.5 Constraints

Current forest management practices of both Forest Enterprise and English Nature appear to be constraints to the effective conservation of the forest. The silvicultural plantation system is still linked to a specific style of harvesting, the clear-cut system, which is disruptive to wildlife. Furthermore, the uncompromising selection of commercial species, many exotic, greatly reduces the intrinsic biodiversity of the forest. Conservation action seems to be too prescriptive, imposing a fixed style of management on the forest. An important element of conservation is the manipulation of habitats for desired species and yet this practice is increasingly becoming state-of-the-art wildlife gardening, not in harmony with the natural ecosystem. All these aspects of conservation have considerable cost. For instance, existing deer fencing at an estimated £2500 per hectare, uses 85% of the earnings from timber sales. This balance will move further into the red once the coppicing programme is on rotation and earnings from sales drop.

8.2.6 Rationale

The main reason given by the Nature Conservancy Council (1989) for promoting and maintaining a coppice management system is the perpetuation of the vernal community, and the long-term conservation of patch-demanding species such as the Fritillary butterflies. However, it is not certain how selective these species are in their habitat requirements. A study in Wyre on the movements of Pearl bordered Fritillary by Bingham and Taylor (1987) demonstrated that individuals may travel over 600m through high forest from one glade to another. Personal observation of this species and Silver-washed Fritillary *confirmed these findings and* also noted that ovipositing females were found in small isolated patches (50 m^2; 150 m^2; and 300 m^2). This would rule out the need for large interconnecting coppice glades and suggests that a system of much smaller randomly-spaced multiduplicate patches would serve the needs of these butterflies. Recent work on plant communities of coppice woodlands (Barkham 1992) suggests that the growth of many intrinsic woodland species is not necessarily dependent on coppicing. However, this study has shown that coppicing can alter species assemblages sufficiently to introduce new guilds into an otherwise homogeneous vegetation and that these associations add to the diversity of plantlife in the forest. Set against this background is the impact of edge-effect on species and communities brought about by induced patch dynamics (Brewer 1994). Habitat edges can concentrate the activities of predators which in turn can seriously reduce populations of certain species (Brewer 1994). Furthermore, heavy predation can reduce overall biodiversity of an ecosystem (Huston 1994). In Wyre, the Wood ant (*Formica rufa*) is a keystone predator and it occurs in large numbers throughout the forest. However, the distribution of populations is strongly influenced by woodland habitat edge. The highest proportion of nests are located at the edges of coppice coupes, plantations and rides (FIGURE 8.2.6.1). Similarly, the local population of Fallow deer (*Dama dama*) favours areas of the forest with dense scrub cover and rich feeding grounds and these optimum conditions are often associated with recently established coppice coupes and forest rides. Consequently, the deer numbers appear to be highest in these managed areas (FIGURE 8.2.6.2). The longterm impact of intensive browsing along ridesides and coupe boundaries is to create a more induced vegetation edge-effect within the woodland (refer to Chapter 5). Changes to the vegetation structure as a result of deer browsing can occur in the field layer as well as the shrub and canopy cover (FIGURE 8.2.6.3). These induced edges can favour fugitive species as well as mobile predators (Brewer 1994). The extent and size of coppice coupes may also influence the level of disturbance in a forest system by promoting synchronised successional patterns. In turn, blocks of uniform vegetative growth may encourage both pest and pathogenic attack as witnessed with *Kermes quercus* infestation in Wyre (FIGURE 8.2.6.4).

In view of the ecological and financial considerations of conservation management there is a need to develop a strategy which is more cost-effective; which will promote sustainable forestry; and ensure that the ecological integrity of the forest is maintained. To achieve this aim requires a change in the coppice management system although it is recognised that in the absence of natural disturbance agents continued active intervention management is necessary. Marketable timber can be generated with minimal disturbance to the ecosystem. Such a strategy is practised in parts of Europe by selection systems, and by irregular shelterwood forest management, both of which are suitable for Wyre.

FIGURE 8.2.6.1 Ant nest (*Formica rufa*) distribution patterns, Wyre Forest

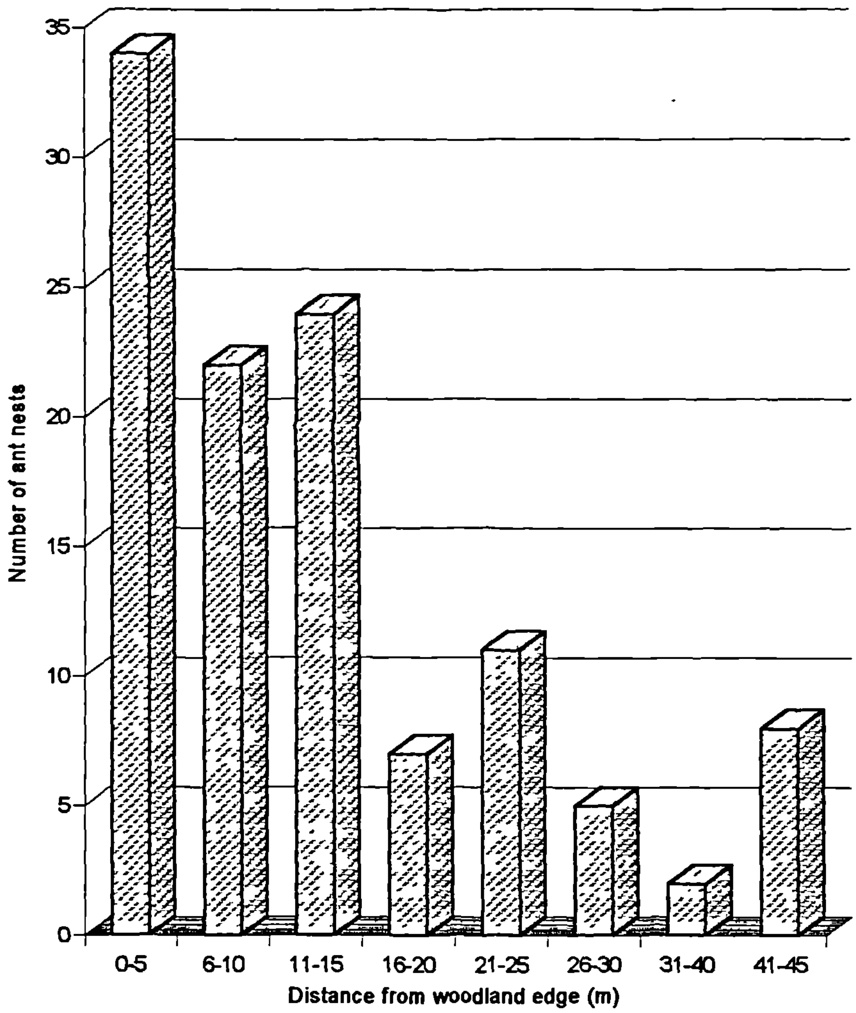


FIGURE 8.2.6.2 Correlation of deer numbers with area of glade/ride, Wyre Forest

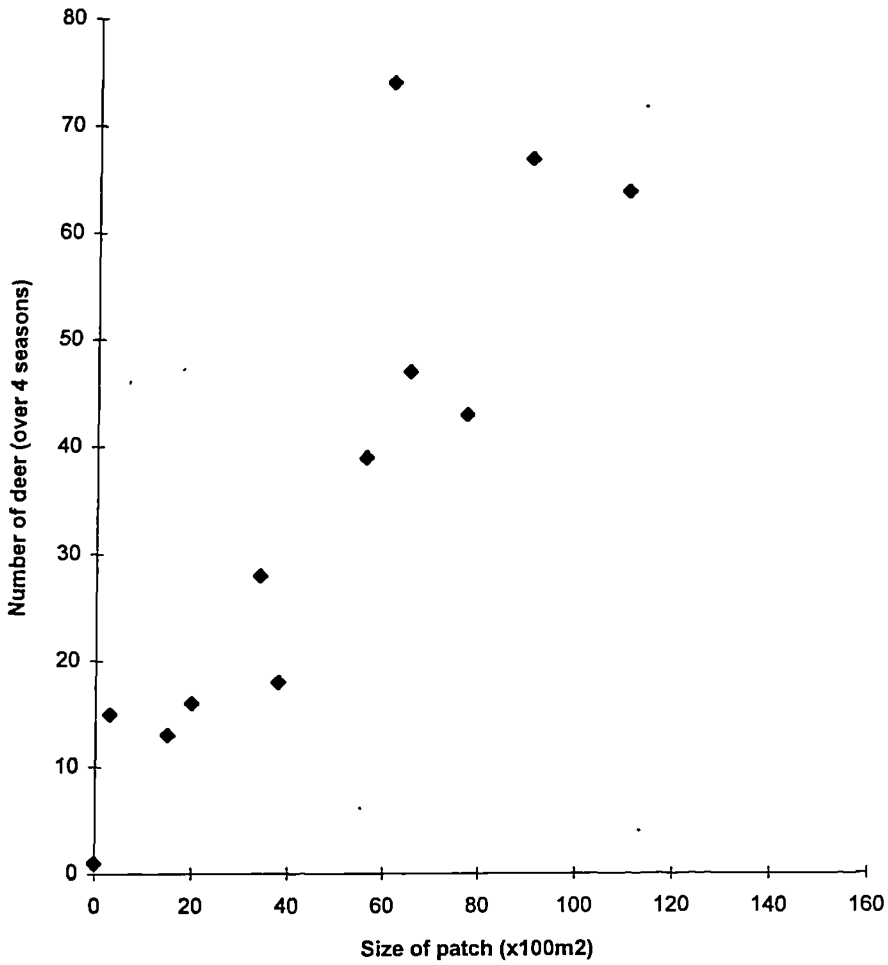
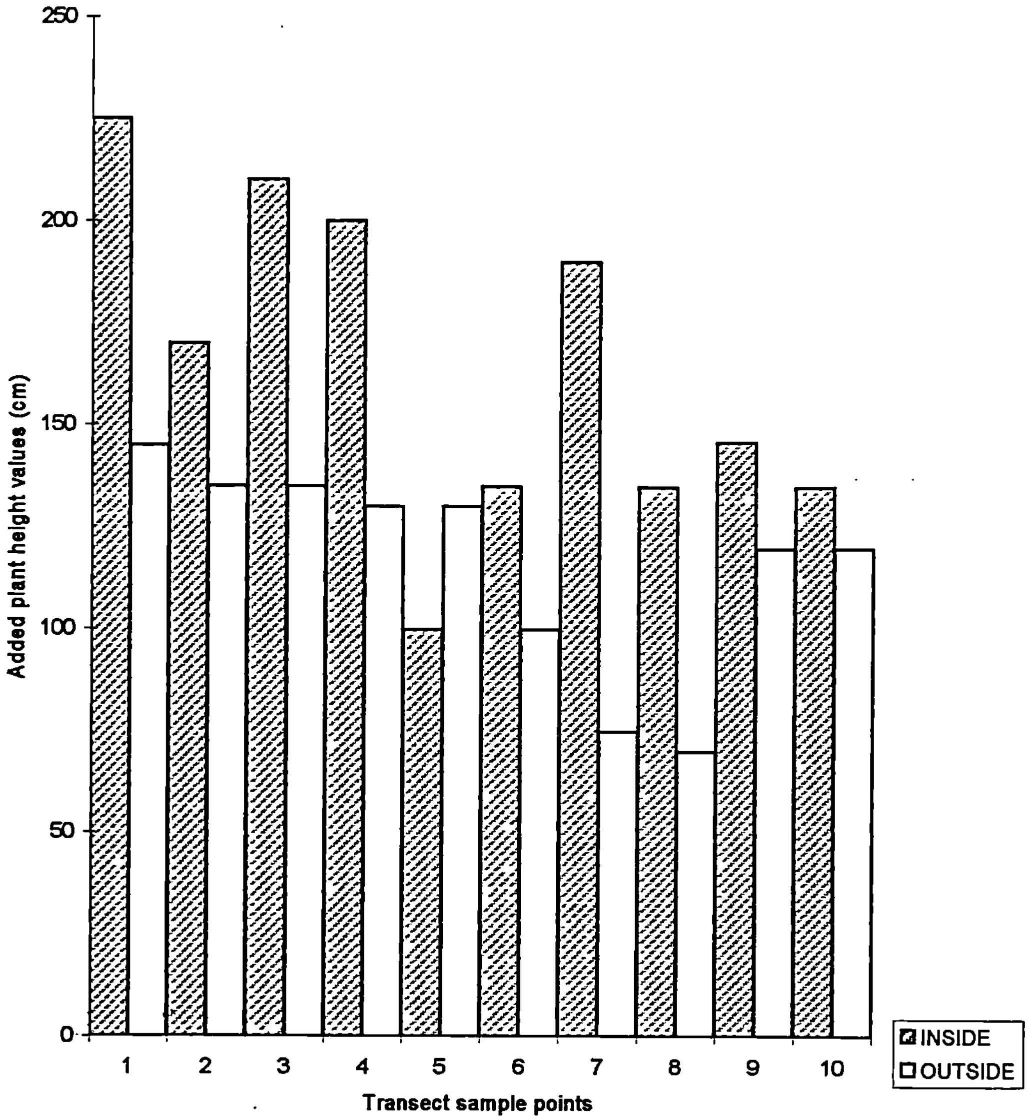


FIGURE 8.2.6.3 Comparative measure of height of Rubus fruticosus either side of deer exclosure fences, Wyre.



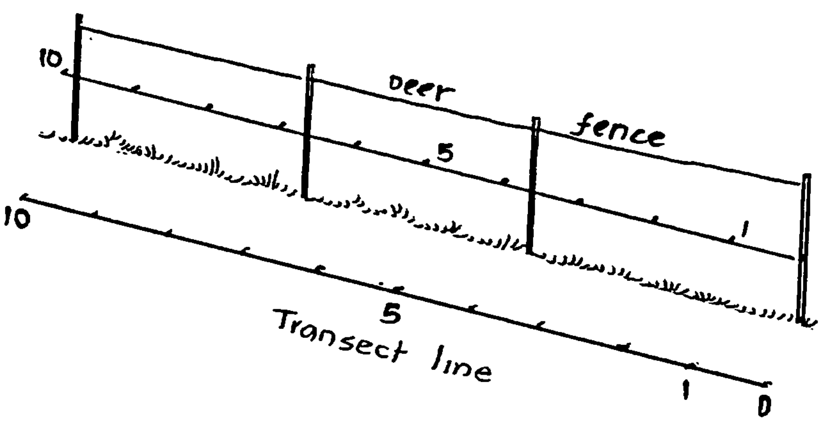


FIGURE 8.2.6.4 a) Extent of *Kermes quercus* infestation on oak for various stem-size classes - Wyre

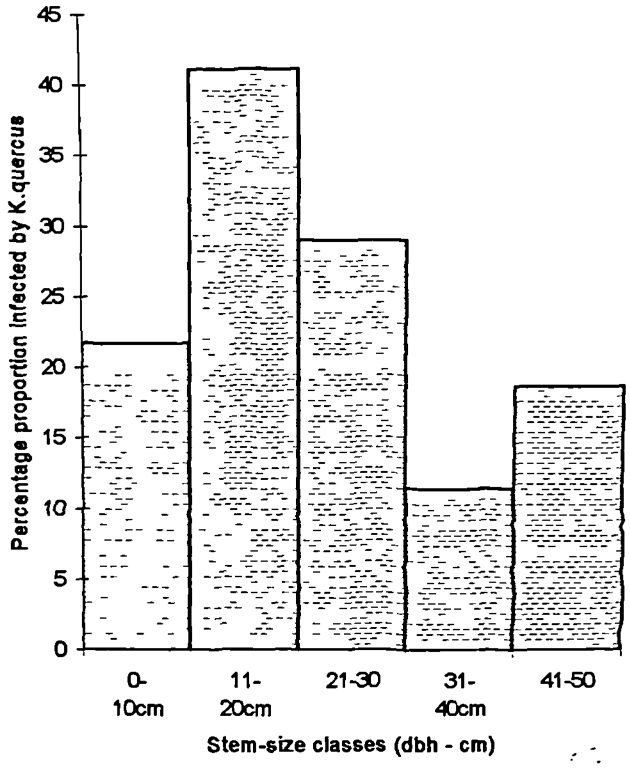
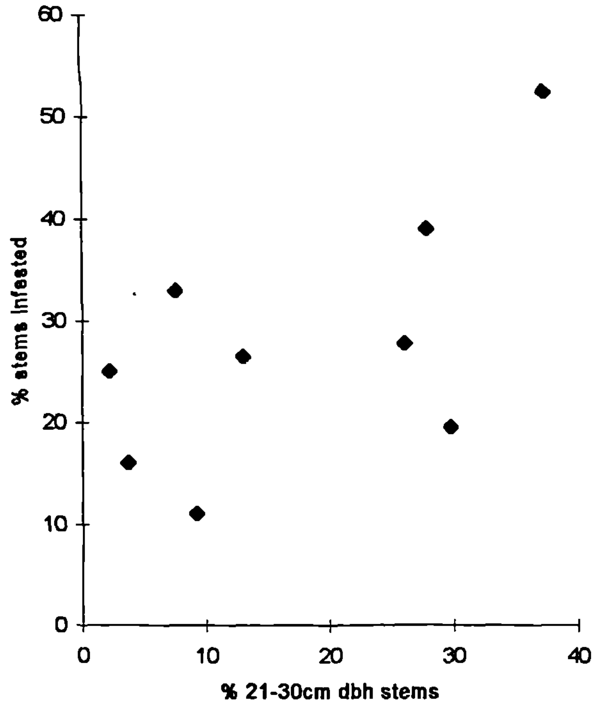


FIGURE 8.2.6.4 B) Kermes infestation and its relationship to the percentage of 21-30cm dbh stems (p=0.614 p>0.025)



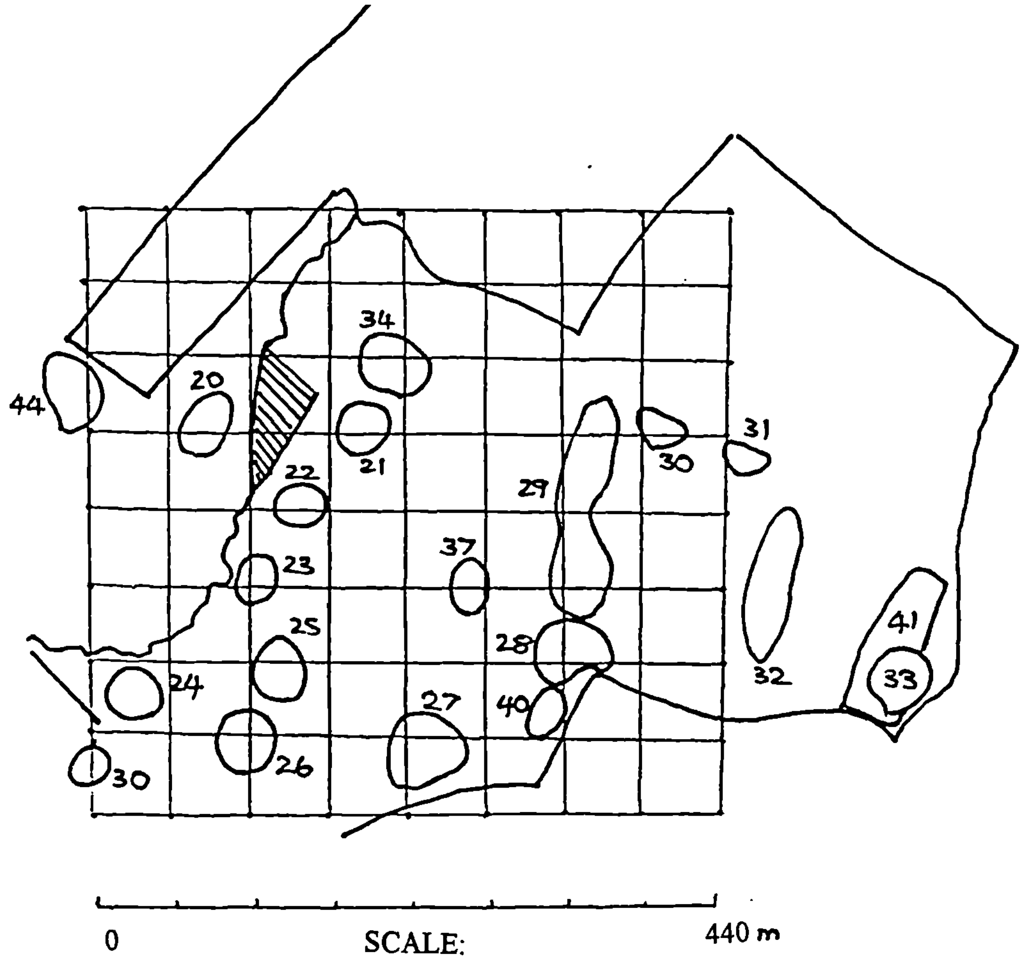
8.2.7 Prescription

Ancient semi-natural woodland and reserve areas

Oak woodland

For the most part of Wyre it is recommended that systematic coppice management should be replaced by a system of management more closely related to the selection system. Random patches of canopy gaps would replace coppice coupes and the total area of these glades would not exceed much beyond the average total area of patches of a natural forest, 0.5 - 2% (Buckley 1992). With the semi-natural areas of the forest amounting to 550 hectares, the total area of open sites would be between 2.5 - 10 hectares. However, the prescribed area of open canopy should be smaller than this if a longer gap rotation is to be encouraged in any one part of the forest. This would allow for the development of mature woodland with large veteran trees. An appropriate area of clearance would be between 1.6 and 2 hectares a year (similar to the current rate). Glades would range in size from 100 m^2 to about 2000 m^2 to ensure the survival of light-demanding species (Packham et al. 1992). This would allow for a lower density of glades to those currently in existence (FIGURE 8.2.7.1), and with greater spacing between these open sites. Smaller, widely dispersed glades would reduce the scale of interior fragmentation present in the current scheme of coppice and silvicultural management. Furthermore, it would increase heterogeneity by providing greater variation in both vertical and horizontal cover, an important consideration to wildlife conservation (Gullion 1982). After a fell, the cut areas are to be left for an extended period (at least 150-200 years) with fencing carried out where necessary. Extended rotation cuts would ensure that no one site developed an induced vegetation boundary but rather the true forest plantlife would have time to recover and promote continuity throughout the habitat. Under this system of management an estimated 250 trees, greater than 25 cm dbh, would be felled each year (this value is the estimated density of "large" trees per hectare calculated from 72 quadrat samples). This calculation does not take into account the available smaller cord wood. The establishment of a selective system would ensure a

FIGURE 8.2.7.1 Section of Symond's Stool Coppice, National Nature Reserve, Wyre Forest, with the location of coppice coupes cut since 1984
(Grid lines give an indication of the area and density of glades in this part of the forest).



Size of gridded site = 19.7 hectares.

Coupe number	Size: (m2)
20	4000
21	600
22	600
23	900
24	800
25	200
26	1200
27	8000
28	5600
29	60000
30	200
31	200
34	600
37	900
44	400
TOTAL	84200

regular supply of up to 150 - 200 tonnes of wood a year (the current system of coppicing would not guarantee such a quantity of marketable timber). A substantial number of trees (15-20% of stock) within the forest should also be allowed to extend beyond the increment stage and develop as hulk trees. Valley woodlands would be managed in much the same way, by cutting similar sized gaps in the canopy at well-spaced intervals. Again it is important to retain old trees within the stands.

Woodland meadows

Areas of open grassland within the forest, maintained for the preservation of specific communities, should not exceed their current size. The edge effect of these forest meadows should be reduced by ensuring that corners and edges are rounded-off by encouraging the growth of a robust scrub margin. The creation of corridors to link these open glades should be avoided as these often encourage predator highways and also promote the development of induced edges in extended linear tracts through the forest. These in turn form distinctive barriers to the movements of both plants and animals.

Silvicultural plantations

The system of management current in the state-owned section of Wyre should be replaced by a shelterwood system, either group or irregular shelterwood. Under such a programme the future planning of forestry operations will not require compartments and this, in turn, will help reduce the edge effect. To promote continuity of the forest habitat a mixed broadleaved-conifer stand should be encouraged. In commercial mixed stands a block and matrix layout of groups of 12 or 16 broadleaved trees at 10 m to 12 m centres is considered effective (Evans 1984). However, under a shelterwood system this ordered planning is unnecessary. Oak-Scots pine, or oak-Douglas Fir are considered good mixtures (Evans 1984); in this case oak should account for 20% of the mixture. This would encourage habitat networking with the surrounding wind belts and semi-natural stands. Where oak - beech stands are selectively managed to favour the best tree these stands should maintain at least 20% oak at all times. A number of old oak trees (approximately 9 per hectare) should be retained within the stands to provide habitat for bark-dwelling organisms. Furthermore, where group or selective thinning has been carried out, a proportion of the regenerating pioneer species such as birch should be retained. Retaining a scattering of birch for the establishing crop is a useful practice both to help minimise frost damage and significantly reduce weed growth (Evans 1984). It also maintains continuity of habitat whilst adding ecological diversity to the woodland.

Thinning and harvesting programmes should be carried out with consideration to the forest environment. Forest activities should avoid the bird breeding season. Both wetland habitats (including springlines) and archaeological features need to be protected during the extraction of timber. Brash from felled conifer trees should be piled on dry sites. The need for wildlife corridors should diminish under a shelterwood system of management as selective or group fells would provide adequate clearings and the high proportion of broadleaved trees in the stands would facilitate habitat networking. Wildlife corridors are believed to have a limited use and may even prove destructive to stenotopic wildlife as they open up edges and increase habitat fragmentation (Brewer 1994).

Deer and Grey squirrel

Deer browsing activity *is important* in the conservation of Wyre Forest. In the absence of the original herbivores the Fallow deer are a valuable 'cropping agent'. However, recent silvicultural changes coupled with an increase in deer numbers has resulted in severe browsing pressure problems over much of the forest (Chapter 7). This has been compounded by efforts to reduce browsing through the use of deer exclosures. Fencing-off recently coppiced woodland has concentrated browsing in unprotected areas and also attracted small herds of feeding deer to the perimeters of the exclosures. Future cull figures should be set against the environmental impact of the deer herd. This would require the annual monitoring of the forest vegetation to record the extent of tree regeneration in both closed-canopy stands and patches. Specified limits on tree regeneration would have to be agreed before a cull figure is set, e.g., more than a 20% loss of seedling growth constitutes unacceptable damage. The current optimum deer-stocking density for a forest is given as 5-8 head per km^2 (Ratcliffe 1992). However, it is unclear whether this value is for broadleaved woodland; mixed conifer-broadleaved plantations; or woodland with both conifer and bradleaved stands. Studies on Fallow deer in Wyre (Bradley 1996, unpublished) show that herds make specific use of thicket stage conifer, particularly plantations abutting oak woodland. They also utilise plantation and woodland boundaries irrespective of herd size; consequently browsing damage is most evident along edges and close to safe sites (cf. Figure 8.2.6.3). On this basis it is more prudent to set a cull figure on the evidence of tree and shrub regeneration.

The use of squirrel hoppers should be avoided because of the risk to other small mammals and those species which prey on them. Squirrel activity should be monitored each year and where damage to trees is high limited trapping and "dray-poking" could be used to control population numbers.

RECREATION

The current system of 'zoning' and 'passive policing' within the state-owned areas of Wyre Forest appears to work well with fewer than 20% of week time visitors leaving forest tracks (Otley College survey 1995). However, the location of designated routes needs more consideration with respect to both visitors and wildlife. Few of the routes in main block Wyre offer interesting features such as view points, one factor encouraging off-track pressure (Otley College survey 1995). The recreational zoning programme is based on a crude measure of restrictions on forest-use by the public rather than a spectrum of recreation opportunities in the forest, and experience norms (Becker and Jubenville 1982). The spectrum of recreation opportunities works on the principle of a continuum from the heavily developed landscape (the Wyre Forest visitor centre), to the totally undeveloped (National Nature Reserve areas). Along this continuum *anchor points* (experiences) would be identified with specific qualifying descriptors to distinguish one anchor point from another. The continuum is the total recreational experience spectrum (RES) of which there are five types of experience level. In Wyre Forest these should break down as shown in TABLE 8.2.1. Once recreation experience and environmental modification norms have been identified it is important to establish the management objectives for which considerations include:

Resource capacity/ capability;
Institutional constraints;
Existing situation;
User preferences;
Co-ordination.

TABLE 8.2.1 Recreation Experience and Environmental Modification Norms proposals for Wyre Forest.

Experience level	Recreation Experience norm	Environmental Modification Norm
1.Primitive	Sense of adventure, sense of solitude, small groups	No site modification, no motorised access, (beyond current red route)
2.Secondary primitive	Sense of adventure, physical stamina not essential.	Little site modification, some design for site protection only. (Red route limits)
3.Intermediate	Sense of adventure, sense of security, some convenience features.	Natural environment, moderate site modification (equates to green route)
4. Secondary modern	Convenience expected, May rely on programme services for entertainment.	Semi-natural environment, site modified,artificial surfacing of roads. Motorised access. (Blue & yellow zones).
5. Modern	Pleasing environment, novice or gregarious visitor. Secure site, personal comforts, entertainment programmes	Information services, hard surfaces, mowed lawns,landscaped grounds contemporary architecture

The direction of management planning should be dictated by the existing situation (the norms of the existing clientele). For instance, if visitors to the forest are mainly regular folk with an appreciation for the natural environment recreation planning should cater for these. If this policy is not adopted, and development norms are used to dictate the social norms, the result may be *social succession* (Becker and Jubenville 1982) where one user group is displaced by another. This could lead to the breakdown of environmental recreation and the subsequent emergence of "theme-park" recreation. In recent years recreational development has progressed rapidly in Wyre. Earlier attempts at low-key resourcing, and a strong emphasis on the cultural heritage expressed in the environmental interpretation centre, were replaced by a more popular style of presentation and refreshment facilities with the sole aim of increasing visitor numbers. The latest development at the visitor centre has moved even further away from environmental recreation, abandoning wildlife interpretation and increasing the refreshment and amenity facilities. Furthermore, the centre has been franchised out to a private firm with the hope that it will become financially viable.

There is a need to adopt an area-planning process which would include the following underlying actions.

1. INVENTORY:

A complete inventory of the following:
Social subsystem (recreational use, history and archaeology, economics, legal/political inputs);
Biological subsystem (flora and fauna, levels and locations of sensitive sites, hazards, etc.)
Physical subsystem (natural factors such as water, soil, physiography, roads, buildings, etc).

2. DETERMINE BAND OF OPERATION:

Use the approach considered in the management objectives and the factors identified in the recreation opportunities spectrum.

3. ESTABLISH PROGRAMME OBJECTIVES

State programme objectives within the band of operation and the actual clientele group whose norms will be adopted in planning the area. Environmental impact is an important issue which should be incorporated into the programme objectives.

4. DEVELOP AND EVALUATE CONCEPT PLANS

Concept plans are pilot scheme models based on the detailed inventory, and are attempts to test alternative courses of action to meet the programme objectives.

An important consideration in recreation programmes is identifying the recreational carrying capacity of the forest. This may be defined as the type of use that can be supported over a specific time by an area developed at a certain level without causing excessive damage to either the physical and biological environment, or lead to a disappointing experience for the visitor (Becker and Jubenville 1982). Carrying capacity in Wyre forest should not be expressed in design units such as number of car parking spaces or number of picnic tables; rather, it should be based on the environmental sensitivity of the forest. This suggests the need for long-term monitoring and an environmental impact assessment.

Recreation management should desirably be reviewed every five years, as often practised, to take account of changing ecological circumstances. Routes could be modified with respect to new bird nesting sites or animal territories. However, more intensive forms of recreation such as cycling,horse riding and group-orientated activities should be monitored every two years, and a means of implementing a crisis-response management strategy built into long-term planning. A recreational management strategy for the forest should be drawn up by a forum of all the land owners in Wyre Forest. The strategy should include an agreement on setting an upper limit to the number of 'passive' and 'active' visitors to the forest. This can be achieved by analysing the results of long-term monitoring programmes on visitor pressure, footpath and vegetation surveys.

ORGANISATIONAL CONSERVATION

The positive relationship that exists between Forest Enterprise and English Nature is an encouraging step towards a more integrated holistic approach to the conservation management of the whole forest. However, there is an urgent need for an active management strategy which would incorporate all land owners. A set of common objectives should be devised which would work towards the principal aim of ecosystem conservation. One objective would be prioritising conservation features across the entire forest and an agreement by all landowners for their preservation. Another main objective should be a commitment to long-term wildlife monitoring (currently, efforts made by English Nature to monitor wildlife in Wyre are sometimes sporadic) and for this to be organised and implemented by English Nature. The conservation forum *should also* recognise the need for English Nature's advice on the management of areas outside designated sites.

8.3 SUMMARY

Woodlands in Britain no longer represent a truly natural habitat but more accurately reflect a landscape which has been shaped by human activity over the millennia (Peterken 1986, Rackham 1986, Rodwell 1991). Consequently, it is very difficult to know what the primeval forest looked like in this country.

The natural robustness of woodlands does not make it easy to determine the latent period between environmental impact on a site and the period at which the ecosystem begins to respond strongly to external forces. It could be several hundred years or it could be more than a thousand years, depending on the current diversity, composition and size of the wood. Faced with this dilemma it is hard to predict at what stage of resilience any woodland is at, and how much further damage would be caused by reintroducing traditional style management into a previously neglected woodland. It is clear, from the present impoverished status of many of the authentic woodland (Hickin 1971) species and the fragmented nature of woodlands, that some form of active management is necessary. However, it is also apparent from loss of species diversity and the level of increase in populations of both discretionary and eurytopic species that a rethink on management is necessary. The safest management strategy must be one which ensures the continued survival of existing obligate woodland species whilst also promoting natural dynamics and so procuring long-term stability of the ecosystem. Such a management system, under modern-day constraints, must follow more closely selection or shelterwood systems which are less disruptive than more traditional forms of management. Furthermore, no one recipe can be used to serve the ecological requirements of all woodlands. Shelterwood systems are flexible enough to allow for a wide selection of management prescriptions.

Successful wildlife conservation can come only from careful observation and monitoring of the environment combined with an uncanny ability to mimic the laws of nature. Any other forms of practice are not strictly embraced by this concept but rather take on a more cultural perspective, whether it is in the form of selective preservation of species and their habitat or the protection of a landscape heritage. It is conceivable that human impact has brought about irrevocable changes in the natural World and that wildlife conservation (a cultural entity in itself) will always bear the hallmarks of human interference. In order that semblances of the natural world may survive human society it is important that they be viewed with an objective eye and become divorced a little more from human culture. In particular, the practice of prescribing intensive management for a site or species is most subject to human bias and yet it is often viewed as the most important element of conservation. As management by prescription takes on new levels of sophistication it is rapidly becoming a sub-culture in itself.

It may pay in the long run to be cautious in imposing extreme conservation practices until a wiser understanding of the natural world has been achieved through continued observation and evaluation.

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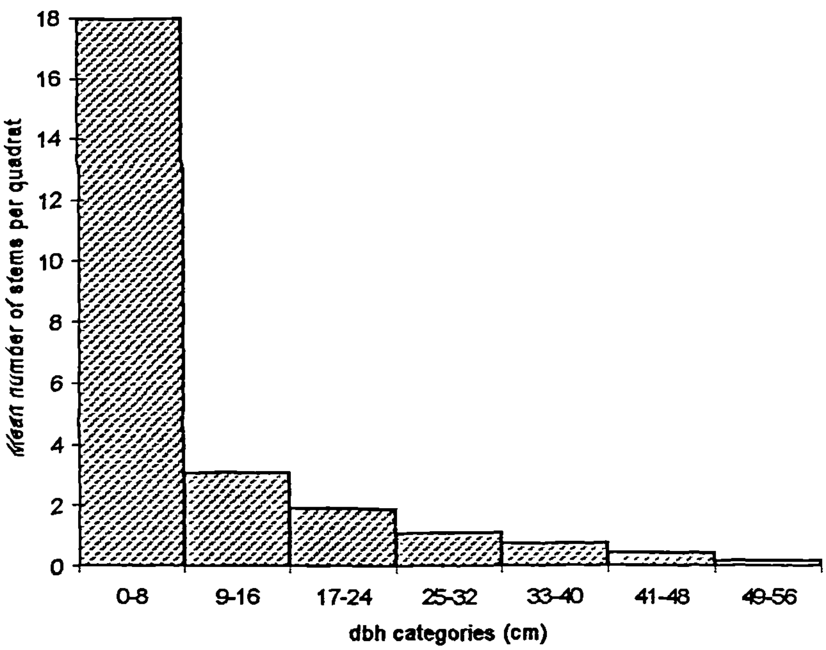
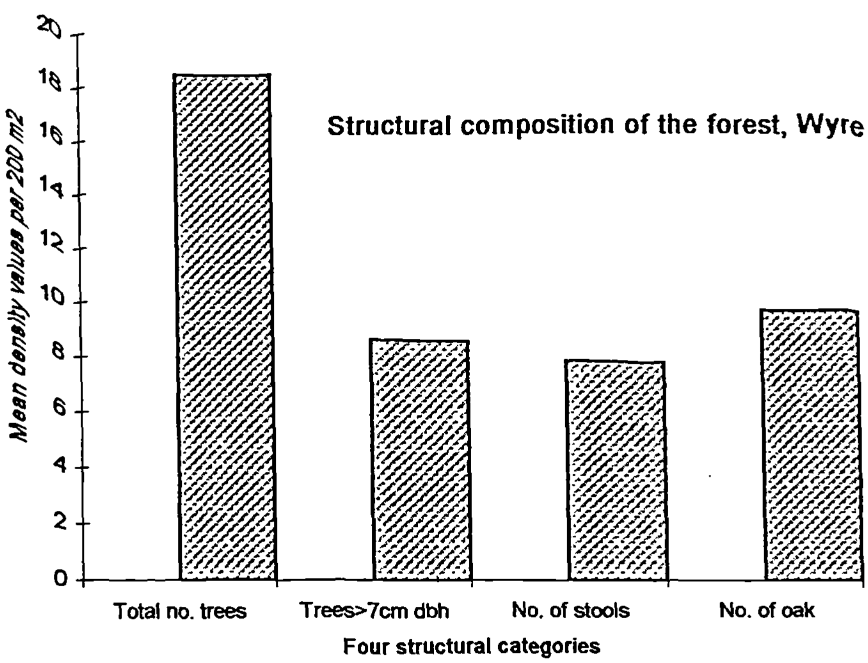
APPENDIX

APPENDIX 4.5.1 Statistical values for the stem dbh data collated from 72 quadrat samples.

		SUMMATION OF THE STEM SIZE-CLASS DATA, WYRE FOREST							
		COLLATED FROM 72 QUADRAT SAMPLES							
				SIZE CLAS	(CM)				
		0-8	9-16	17-24	25-32	33-40	41-48	49-56	HOLLY
MEAN		17.98947	3.043011	1.892473	1.086022	0.747368	0.41894	0.178947	3.136364
STAN. DEV		25.5728	5.581246	3.139726	1.479247	1.110572	0.662507	0.483316	2.730698
RANGE		146	33	15	6	5	3	2	9
MIN		0	0	0	0	0	0	0	1
MAX		146	33	15	6	5	3	2	10

Mean number of stems per 200 m2 for each dbh size category, Wyre Forest





APPENDIX 4.5.2

A comparison between plateau and valley woodlands of the number of coppice stools and trees with a dbh greater than 7 cm
(values are given as total numbers per 200 sq. m)

	Valley woodland		Plateau woodland	
	22		3	4
	12		5	17
	7		14	38
	4		7	16
	8		2	16
	15		7	6
	40		16	17
	34		20	4
	22		9	37
	27		18	7
	11		11	3
	12		10	4
	25		13	4
	16		10	7
	10		2	5
	15		5	8
	17		8	13
	18		11	12
	12		8	9
	20		11	8
	6		42	13
	31		12	12
	12		11	11
	13		10	7
	6		15	10
	12		29	
	13		11	
Total =	440		Total =	608

Student's t-test:

Degree of variance for plateau data = 27.80552

Degree of variance for valley data = 28.926

F value = 1.040
Critical value for F = 2.669
Therefore difference in variance values is not significant.

Calculated t value = 2.01

Value suggests there is a significantly greater density of stems in Valley woodlands.

APPENDIX 4.5.3

A comparative analysis using Chi-square of the stem density data for four forest structural stands

		Stem values used in the comparison between the structural					
		stand-types - wyre.					
				Structural stand-types			
		High forest		Traditional		Stored	Post clearance
				woodland		coppice	regeneration.
	37	4	11	12		20	22
Total No.	3	3	57	7		9	19
of stems/	9	6	12	16		19	31
200 sq. m	11	8	9	12		8	38
	19	5	9	11		15	17
	11	6	19	9		8	17
	14	T= 347	9	15		13	20
	12		26	12	T=92		7
	24		16	14			7
	10		14	22			12
	17		19	32			T=190
	5		13	19			
	10		16	15	X2 analysis - compare total number of stems between:		
	12		21	12	High forest/Traditional woodland		
	6		13	18	X2 = (347-467)2/467		
	10		12	4	X2=30.8		
	4		14	23	Significantly larger number of		
	9		12	23	stems in traditional woodland		
	7		14	17			
	9		18	17	X2 analysis - compare number of stems in dbh class, 9-16cm,		
	6		17	12	High forest/Traditional woodland		
	7		9	9	X2 = (60-111)2 / 111		
	12		25	14	X2 = 23.4		
	4		7	22	Significantly larger number of stems of this size		
	12		19	2	in traditional woodland stands.		
	8		13	T=838			
	4		5		X2 analysis -compare number of stems in dbh class, 17-24cm,		
	13		22		High/Traditional woodland		
	10		18		X2 = (85-62.9)2/62.9 = 7.76. There are significantly more stems in Trad. woodland		

APPENDIX 5.2.1.

Stem data values for two woodland stand-types, oak-heath and mixed oak woodland, Wyre Forest.								
		Oak-heath	stand-type			Mixed oak woodland		
Categories		Stools	dbh>7cm	Total No.		Stools	dbh>7cm	Total No.
		12	9	25		3	2	37
		7	9	19		0	3	3
		5	15	21		8	6	19
		3	8	11		0	7	16
		5	4	9		0	7	7
		3	7	19		4	6	12
		2	9	15		2	11	14
		0	11	14		3	7	11
		4	8	23		4	6	22
		3	8	13		0	2	2
		4	6	11		2	3	13
		5	5	12		2	6	9
		10	9	26		10	6	18
		3	10	13		1	9	14
		1	4	5		1	14	18
		9	3	38		10	3	25
		0	9	12		4	2	7
		6	3	13		2	10	14
		1	14	16		4	11	17
		5	5	39		0	9	10
		0	8	10		0	4	4
		0	7	16		4	3	18
		2	10	18		0	3	3
		11	4	24		4	7	13
		7	13	21		3	7	12
		14	4	27		0	4	4
		0	8	10		1	4	5
		3	9	18		4	4	9
		2	5	9		5	15	20
	SUM:	127	224	507		3	4	13
						1	4	5
					SUM:	85	189	394

Comparison between two oak woodland habitats of the total density of trees (difference between oak stands in degree of variance for the data sets is significant, therefore, a Student's t-test cannot be used).

Calculated Chi value is 14.4 (critical value is 3.88). There is a significant difference in the total density of trees between the two oak stands.

Comparison between two oak woodland habitats of the density of trees with a dbh greater than 7 cm.

Degree of variance for mixed oak woodland = 11.26
Degree of variance for oak heath woodland = 34.20
F value = 3.306

The difference in variance between data sets suggests that a Student's t-test cannot be used to determine the difference in stem density values between the two woodland habitats.

Calculated chi value is 2.83 (critical value = 3.88)
There is no apparent difference in density of trees with dbh greater than 7 cm

APPENDIX 5.2.2 Floristic table for mixed oak woodland

Quercus petraea	V (5-9)
Betula pendula	IV (2-8)
Ilex aquifolium	III (1-4)
Acer pseudoplatanus	I (7)
Alnus glutinosus	I (4)
Prunus avium	I (4)
Taxus baccata	i (3)
Tilia cordata	I (3)
Sorbus aucapria	I (1-3)
Sorbus torminalis	I (1-2)
Populus tremula	I (2)
Corylus avellana	II (2-9)
Crataegus monogyna	II (1-4)
Fraxinus excelsior	I (4)
Salix hybrids	I (4)
Prunus spinosa	I (1)
Viburnum opulus	I (1)
Holcus mollis	V (2-10)
Rubus fruticosus agg.	V (2-7)
Pteridium aquilinum	IV (2-7)
Lonicera periclymenum	IV (2-4)
Hyacinthoides non-scripta	III (1-5)
Deschampsia flexuosa	III (1-5)
Teucrium scorodonia	III (1-4)
Viola riviniana	III (1-4)
Agristis capilaris	II (1-4)
Vaccinium myrtillus	II (1-4)
Anemone neomorosa	II (1-3)
Oxalis acetosella	II (1-3)
Euphorbia amygdaloides	II (1-2)
Melica uniflora	I (2-8)
Deschampsia cespitosa	I (1-6)
Luzula sylvatica	I (1-6)
Blechnum spicant	I (1-5)
Lamiastrum galeobdolon	I (1-4)
Brachypodium sylvaticum	I (1-5)
Juncus effusus	I (5)
Dryopteris dilatata	I (1-4)
Dryopteris filix-mas	I (1-4)
Galium palustre	I (1-3)
Millium effusum	I (1-3)
Carex montana	I (1-2)
Mnium hornum	I (1-2)
Polytrichum formosum	I (1-2)
Potentilla erectus	I (1-2)
Potentilla sterilis	I (1-2)
Anthoxanthum odoratum	I (2)
Melampyrum pratense	I (2)
Convalaria majalis	I (2-3)
Lysimachia nemorum	I (1-2)
Sanicula europaea	I (2)
Alium ursinum	I (1)
Calluna vulgaris	I (1)
Conopodium majis	I (1)
Galium saxatile	I (1)
Hedera helix	I (1)
Stellaria media	I (1)
Veronica officinalis	I (1)
Thuidium tamariscinum	I (1)

APPENDIX 5.2.3 Floristic table for oak-heath woodland.

Quercus petraea	V (7-9)
Betula pendula	IV (1-6)
Ilex aquifolium	III (1-5)
Sorbus aucuparia	II (1-2)
Crataegus monogyna	I (1)
Sorbus torminalis	I (1)
Quercus petraea	V (2-7)
Betula pendula	III (2-6)
Ilex aquifolium	II (4-5)
Sorbus aucuparia	I (2)
Deschampsia flexuosa	V (4-7)
Vaccinium myrtillus	V (1-8)
Lonicera periclymenum	IV (1-4)
Calluna vulgaris	IV (2-7)
Rubus fruticosus	IV (1-4)
Pteridium aquilinum	III (3-7)
Dicranum scoparium	III (1-4)
Teucrium scorodonium	III (1-4)
Anemone nemorosum	II (1-4)
Holcus mollis	II (1-4)
Polytrichum commune	II (1-4)
Pseudoscleropodium purum	II (2)
Galium saxatile	II (1)
Viola riviniana	II (1-2)
Agrostis capilaris	I (1-4)
Melampyrum pratense	I (1-2)
Anthoxanthum odoratum	I (4)
Brachypodium sylvaticum	I (4)
Melica uniflora	I (3)
Hedera helix	I (2)
Hyacinthoides non-scripta	I (2)
Luzula pilosa	I (2)
Potentilla sterilis	I (2)
Erica cinerea	I (1)
Euphorbia amygdaloides	I (1)
Luzula sylvatica	I (1)
Mnium hornum	I (1)
Polygala serpyllifolia	I (1)
Potentilla erecta	I (1)
Veronica officinalis	I (1)
Number of samples	19
Number of species per sample	10 (4-19)
Tree cover (%)	68 (30-85)
Shrub cover (%)	19 (0-65)
Herb cover (%)	78 (35-95)

5.2.4 Floristic table for ash-oak woodland, Wyre

Quercus hybrids	V (7-10)
Fraxinus excelsior	III (5-9)
Ilex aquifolium	III (1-2)
Prunus avium	III (1-5)
Betula pendula	III (4)
Acer pseudoplatanus	II (1-7)
Salix hybrids	II (2-7)
Corylus avellana	V (5-9)
Crataegus monogyna	V (1-7)
Quercus hybrids	III (1-5)
Fraxinus excelsior	II (1-4)
Prunus avium	II (1-4)
Ilex aquifolium	II (1-2)
Acer Pseudoplatanus	II (4-5)
Betula pendula	II (2-5)
Salix hybrids	II (1-4)
Acer campestre	II (1)
Cornus sanguinea	I (4)
Viburnum oppulis	I (1)
Rubus fruiticosus agg.	V (2-8)
Viola riviniana/reichenbachiana	IV (1-5)
Lamiastrum galeobdolon	III (4-8)
Mercurialis perenis	III (2-5)
Hedera helix	III (2-4)
Euphorbia amygdaloides	III (1-2)
Dryopteris filix-mas	III (1-4)
Geum urbanum	III (1-4)
Holcus mollis	II (4-8)
Melica uniflora	II (4-6)
Hyacinthoides non-scripta	II (5)
Pteridium aquilinum	II (3-4)
Brachypodium sylvaticum	II (1-4)
Potentilla sterilis	II (1-4)
Mnium horum	II (2-3)
Geranium robertianum	II (1-3)
Oxalis acetosella	II (1-3)
Galium aparine	II (1-3)
Deschampsia cespitosa	II (1-2)
Stellaria media	II (1-2)
Lonicera periclymenum	II (2)
Luzula sylvatica	II (1)
Dryopteris dilatata	I (1-4)
Urtica dioica	I (1-4)
Athyrium filix-femina	I (3)
Glechoma hederacea	I (3)
Teucrium scorodnium	I (3)
Millium effusum	I (1-3)
Ajuga repens	I (2)
Arum maculatum	I (1-2)
Rosa canina	I (1-2)
Lysimachia nemorum	I (2)
Anemone neomorosum	I (1)
Epilobium angustifolium	I (1)
Festuca gigantea	I (1)
Juncus inflexus	I (1)
Plagiomnium undulatum	I (1)
Stachys sylvatica	I (1)
Veronica montana	I (1)
Number of samples	**10**
Number of species per sample	**17 (11-29)**
Tree cover (%)	**68 (20-85)**
Shrub cover (%)	**59 (35-95)**
Herb cover (%)	**81 (40-95)**

appendix 5.2.5 Floristic table for valley/springline woodland

Quercus hybrids	V (5-9)
Alnus glutinosus	IV (4-8)
Fraxinus excelsior	III (1-5)
Betula pubescens	II (4-8)
Populus x nigrans	I (5)
Salix hybrids	I (4-6)
Prunus avium	I (1-3)
Sorbus torminalis	I (3)
Ilex aquifolium	I (4)
Tilia cordata	I (1)
Coryllus avellana	V (1-10)
Crataegus monogyna	II (1-4)
Sorbus aucuparia	I (4)
Alnus glutinosus	I (3)
Taxus beccata	I (3)
Viburnum opulus	I (1)
Rubus fruticosus agg.	IV (1-7)
Deschampsia cespitosa	IV (1-5)
Holcus mollis	IV (1-5)
Lamiastrum galeobdolon	IV (2-4)
Allium ursinum	III (5-9)
Carex pendula	III (4-8)
Oxalis acetosella	III (1-5)
Lysimachia nemorum	III (1-3)
Hyacinthoides non-scripta	II (4-7)
Mercurialis perennis	II (2-6)
Carex remota	II (2-7)
Anemone nemorosa	II (1-4)
Dryopteris filix-mas	II (2-4)
Cirsium arvense	II (1-4)
Dryopteris dilatata	II (1-4)
Geranium robertianum	II (1-4)
Ranunculus repens	II (1-4)
Lonicera periclymenum	II (1-2)
Viola riviniana	II (1-3)
Ajuga reptans	II (1-2)
Mnium hornum	II (1-2)
Euphorbia amygdaloides	II (1)
Primula vulgaris	II (1-2)
Filipendula ulmaria	I (4-8)
Chrysosplenium oppisitifolium	I (5)
Equisetum sylvaticum	I (5)
Ranunculus ficara	I (5)
Solanum dolcumara	I (2-5)
Urtica dioica	I (5)
Pteridium aquilinum	I (3-4)
Agrostis capilaris	I (4)
Melica uniflora	I (4)
Brachypodium sylvaticum	I (4)
Ranunculus repens	I (4)
Mentha aquatica	I (4)
Athyrium filix-femina	I (1-3)
Equisetum palustre	I (1-3)
Bromus ramosus	I (3)
Atrichum undulatum	I (3)
Poa trivialis	I (3)
Angelica sylvestris	I (2)
Geum urbanum	I (2)
Juncus effusus	I (1-2)
Carex pilulifera	I (2)
Galium palustre	I (2)
Glechoma hedera	I (2)
Potentilla sterilis	I (2)
Stachys sylvatica	I (2)
Teucrium scorodonium	1 (2)
Valeriana officinalis	I (2)
Veronica beccabunga	I (2)
Galium aparine	I (1)
Hedera helix	I (1)
Rumex obtusifolius	I (1)

Number of samples	13
number of species per sample	15 (9-19)
Tree cover (%)	70 (31-90)
Shrub cover (%)	48 (10-95)
Herb cover (%)	83 (70-100)

APPENDIX 5.2.6 Floristic table for birch mire woodland

Betula pubescens	(5-8)
Quercus hybrids	(4-8)
Alnus glutinosus	(4-8)
Salix hybrids	(4)
Ilex aquifolium	(2)
Populus tremula	(2)
Sorbus torminalis	(1)
Betula pubescens	(4-5)
Salix hybrids	(4)
Crataegus monogyna	(2)
Corylus avellana	(1)
Viburnum opulus	(1)
Molinia caerulea	(7-9)
Carex flacca	(6-7)
Carex remota	(6)
Filipendula ulmaria	(4)
Mentha aquatica	(4)
Pleurozium schreberi	(4)
Valeriana dioica	(4)
Brachypodium sylvaticum	(3)
Lysimachia nemorum	(3)
Viola riviniana/reibechiana	(3)
Plagiomnium undulatum	(3)
Angelica sylvatica	(2)
Dryopteris filix-mas	(2)
Equisetum palustre	(2)
Holcus mollis	(2)
Juncus articulatus	(2)
Lonicera periclymenum	(1-2)
Primula vulgaris	(2-3)
Pteridium aquilinum	(2)
Rosa canina	(2)
Rubus fruticosus agg.	(2)
Vaccinium myrtillus	(2)
Agrostis capilaris	(1)
Ajuga repens	(1)
Carex pilulifera	(1)
Deschampsia cespitosa	(1)
Deschampsia flexuosa	(1)
Euphorbia amygdaloides	(1)
Galium palustre	(1)
Number of samples	4
Number of species per sample	17 (15-20)
Tree cover (%)	77 (65-85)
Shrub cover (%)	15 (10-20)
Herb cover (%)	81 (65-90)

A comparative analysis using Chi-square of the frequency presence values for eight species either side of deer exclosure fences.

EXCLOSURE STUDY - 1996, WYRE FOREST									
FREQUENCY-HIT VALUES FOR EIGHT SPECIES OF PLANT.									
SPECIES:			FREQUENCY-HIT VALUES						
		COUPE I		COUPE II		COUPE III		COUPE IV	
		INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE
Bet pend		30	1	9	10	10	0	17	0
Call vulg		17	2	0	0	52	15	30	0
Gali saxa		0	0	0	0	13	0	0	0
Loni peri		24	8	27	7	8	0	18	8
Rub fruti		90	98	17	5	37	4	59	39
Pter aqui		14	14	26	28	17	6	32	33
Quer petra		66	13	11	15	23	8	8	25
Teuc scoro		21	1	0	0	19	0	5	2
Loni peri	observ	expect	x2=14.58						
	77	50	Significant at 1 degree freedom						
			Higher abundance in exclosure						
Rub fruti	203	174.5	X2=4.65						
			Significant at 1 degree freedom						
			Higher abundance in exclosure						
Call vulg	99	58	X2=29						
			Significant at 1 degree freedom						
			Higher abundance in exclosure						
Bet pend	66	11	X2=19.6						
			Significant at 1 degree freedom						
			Higher abundance in exclosure						

APPENDIX 5.2.8

An assessment of oak seedling growth either side of a deer exclosure fence

DEER EXCLOSURE DATA:			COMPARING THE HEIGHT OF OAK SEEDLINGS INSIDE					
			AND OUTSIDE OF A DEER EXCLOSURE, WYRE					
	QUADRAT NUMBER			HEIGHT (CM)		OF OAK SEEDLINGS		
	INSIDE ENCLOSURE:							
	2		28,19,17					
	4		20,22,13	12,8,14	18,16,13	18,17,11	12,15,11	25,19,27
	6		18,19,19,	25,17,19	17,25,17	29,24,21	18,22,22	25,17,21
			17,12,17	18,23,27	18,25,25			
	8		22,17,19	22,24,24				
	12		14,13,23	14,17,19				
	14		26,20,23	19,28,28	26,8,18			
	16		35,14,17	17,10,15	13,8,9	14,19,17	18,5,	
	OUTSIDE EXCLOSURE:							
	1		11,13					
	3		19,16,18	8,14,23	20,5,13			
	5		14,8,9,	12,12,15	11,10,10	11,12,8	7,15,18	12,14,15
			18,11,14	12				
	7		30,16,23	19,20,15	17,18,11	15,14,17		
	11		0	0	0	0	0	0
	13		17,16,24	21,24,17	15,12,8	14,17,7	29,16	
	15		11,15,18	12,10,11				

EXCLOSURE DATA: COMPARING HEIGHT OF OAK SEEDLINGS INSIDE & OUTSIDE OF								
DEER FENCE - WYRE, 1996								
AN ANALYSIS USING MANN-WHITNEY U-TEST.								
	MEAN Ht.	MEAN Ht.						
	(cm)	(cm)						
COUPE:	inside	outside						
I	91	31		U= 6x6 + 6(6+1)/2 -57				
II	105	10		U = 0				
III	38	15		At 5% level critical value for U = 5				
IV	43	17		The height of seedlings in exclosure				
V	38	14		is significantly greater than outside the fence.				
VI	36	17						

APPENDIX 5.2.9

A comparative analysis using the Mann-Whitney U-test of the height of bramble growth either side of the deer exclosure

DEER EXCLOSURE STUDY - 1996									
COMPARATIVE ANALYSIS OF THE HEIGHT OF BRAMBLE GROWTH									
EITHER SIDE OF THE EXCLOSURE FENCE									
			COUPE NUMBER						
HEIGHT		2	3	4	5	6			
(CM)		39,(25)	52,(30)	56,(35)	52,(40)	18,(10)			
		29,(25)	30,(30)	40,(35)	48,(40)	25,(0)			
		52,(30)	30,(30)	60,(70)	37,(0)	30,(0)			
		40,(25)	36,(30)	64,(0)	44,(0)	18,(0)			
		38,(35)	40,(30)	4,(0)	0,(30)	18,(30)			
		41,(45)	12,(30)	33,(15)	30,(5)	12,(5)			
		46,(30)	30,(35)	70,(20)	35,(0)	14,(0)			
		27,(30)	30,(35)	40,(15)	25,(0)	8,(0)			
		0,(30)	30,(42)	80,(20)	18,(21)	20,(0)			
		11,(35)	31,(35)	47,(25)	21,(20)	15,(0)			
	(VALUES IN BRACKETS - READINGS TAKEN OUTSIDE EXCLOSURE)								
MANN-WHITNEY U-TEST			SUM HEIGHT READINGS:						
			INSIDE		OUTSIDE				
		SUM	R1	SUM	R2				
		217	20	140	14		U=100+ 100+10/2 - 140		
		172	16	130	12				
		209	19	130	12		U=15		
		202	18	55	1		U IS SIGNIFICANT		
		100	4.5	125	8.5				
		128	10	100	4.5		BRAMBLE IS TALLER		
		195	17	85	3		IN EXCLOSURES		
		130	12	80	2				
		148	15	113	6				
		125	8.5	115	7				

APPENDIX 5.4.1

The main areas of grassland surveyed within the Forest Enterprise section of Wyre.

	GRASSLAND SURVEY - 1990, FOREST ENTERPRISE, WYRE		
CATEGORY:	TOTAL AREA (HA)	No. quadrat samples	Mean No. species/quadrat
Road verge	45900	86	8.04+0.64
Rides	53665	65	7.67+0.25
Deer lawns	36295	50	4.67+0.6

APPENDIX 5.4.2

Principal wetland flushes located in the Forest Enterprise section of Wyre Forest

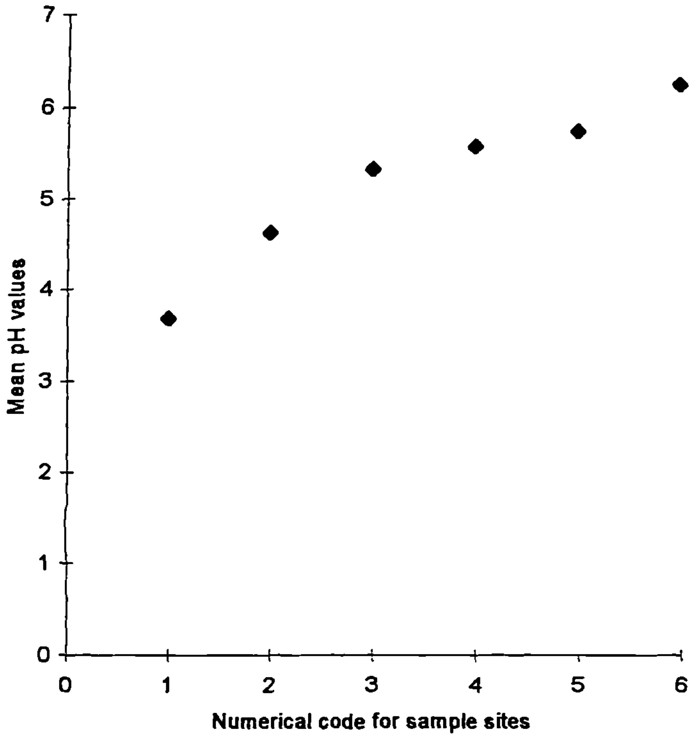
	LOCATION OF WETLAND SITES ON FOREST ENTERPRISE LAND - WYRE							
GRID REF	F.E. COMP CODE		SIZE(M2)		GRID REF	F.E. COMP. CODE		SIZE(M2)
745782		8059a	75		730767		8068b	24
745784		8059c	60		736763		8069a	
741776		8061c	2500		745764		8069a	
743775		8061b	200		743763		8069e	
743776		8061g	2550		743764		8069e	
746771		8062a			742763		8069a	4
746772		8062a			739765		8069h	
747770		8062a			751764		8071a	
746777		8062c	150		751761		8071b	33
747773		8062j	4		746762		8071d	
750768		8064b			747762		8071e	
746770		8064d	8		747763		8071e	
747769		8064d	8		741756		8072a	
747766		8064c	4		741757		8072a	
744776		8062d	12		739756		8073c	
745769		8065h			740759		8073d	
736766		8066a	150		745752		8074b	
733767		8066b	1700		745752		8074b	
728762		8067b	2		745754		8074b	
726763		8067b	30		746756		8074c	
727764		8067b	375		745756		8074c	
728766		8067b	30		744749		8080b	30
733767		8068c			754749		8077f	30
734765		8068c			746750		8074g	16
737764		8068c	12		737797		8043i	600
733765		8068c	1900		751795		8041i	18
743774		8063b	200		745744		8080h	50
739787		8057b	100		752756		8075a	4
741750		8078j	300		747756		8079d	4
747754		8079a	150		748753		8079a	1
748795		8041b	120				8069n	400

APPENDIX 6.2.1 (a, b, c)

pH readings taken for each of the quadrat samples recorded in the eight forestry plantations surveyed in the ISA study.

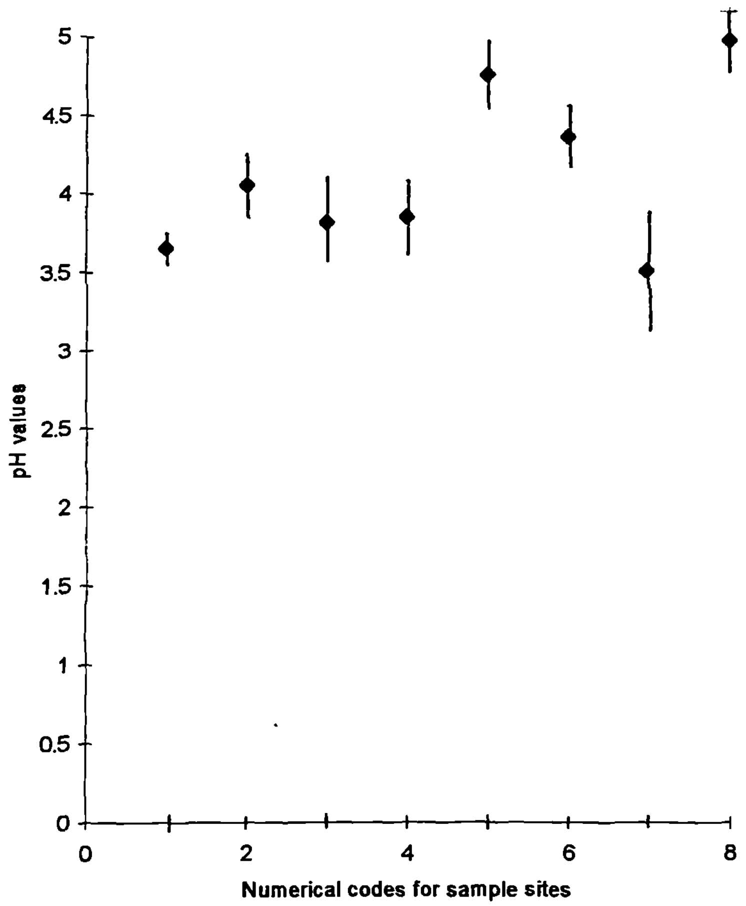
				Forestry plantation compartments					
			Plateau				Valley		
		8059a	8064c	8067a	8068a	8078b	8079j	8070b	8079e
	pH values	3.67	4.62	3.76	3.87	4.15	3.8	5	6.35
		3.75	4.22	3.69	3.88	4.18	3.62	4.73	5.72
		3.5	4.08	3.73	3.48	3.65	3.68	5.14	5.31
		3.53	4.13	3.76	3.85	3.58	3.62	4.68	5.56
		3.44	4.47	3.97	4.04	3.6	3.85	4.65	6.16
		3.69	4.12	3.8	3.98	3.41	3.67	4.63	4.49
		3.59	4.02	3.8	3.65	3.79	3.5	4.54	4.85
		3.44	4.03	3.76	4.03	4.49	3.81	4.42	5.01
		3.78	4.06	3.77	3.9	4.99	3.58	4.42	5.1
		3.58	4.6	3.87	3.85	4.69	3.44	4.97	3.91
		3.63	4.22	3.25	3.75	4.08	3.53	4.85	4.22
		3.51	3.93	3.88	3.4	5.22	3.72	4.2	4.41
		3.73	3.8	3.74	3.84	4.44	3.57	4	4.2
		3.79	3.7	3.83	3.96	3.75	3.6	4.14	4.14
		3.51	3.75	3.65	3.82	4.32	3.72	4.03	4.1
		3.63	3.84	3.85	3.89	3.93	3.71	3.99	4.15
		3.49	3.92	3.82	4	3.55	3.7	4.17	5.36
		3.7	3.68	4.01	4.04	3.78	3.77	4.8	5.73
		3.72	3.7	3.74	3.92	5.3	3.62	4.89	5.02
		4.19	3.77	3.89	3.94	4.96	3.54	4.78	5.4
		4.08	4.04	4.13	4.09	5.36	3.55	5.08	4.26
		3.56	4.2	3.98	4.05	4.75	3.59	5.25	4.71
		3.64	3.95	3.87	3.88	5.23	3.93	5.11	5.81
		3.65	3.9	3.99	3.8	4.33	3.69	5.01	5.17
		3.55	4.01	4.04	3.72	5.51	4.02	5.41	4.41
		3.67	4.11	3.92	3.75	3.9	3.84	5.22	5
		3.59	4.38	3.54	3.91	4.54	3.8	5.4	5.77
		3.744	4.25	3.84	3.74	4.85	3.76	4.97	5.29
		3.67	113.5	3.71	3.56	4.54	3.98	4.78	4.22
		106.024		3.72	3.57	3.84	3.86	5.32	5.19
				114.31	115.16	130.71	111.07	142.58	149.02
						4.357		4.86	

Mean pH values for six wetland sites surveyed in the ISA study, Wyre Forest



Wetland sites	
1	8062c
2	8067b
3	8079c
4	8079a
5	8061j
6	8070c

Mean pH values for the eight plantations surveyed in the ISA study, FE, Wyre Forest



Forestry compartment sites		
1	8059a	oak/beech
2	8064c	Pine
3	8067a	oak
4	8068a	larch
5	8070b	valley oak
6	8078b	D. fir
7	8078j	D. fir
8	8079e	Valley pine

APPENDIX 6.2.2

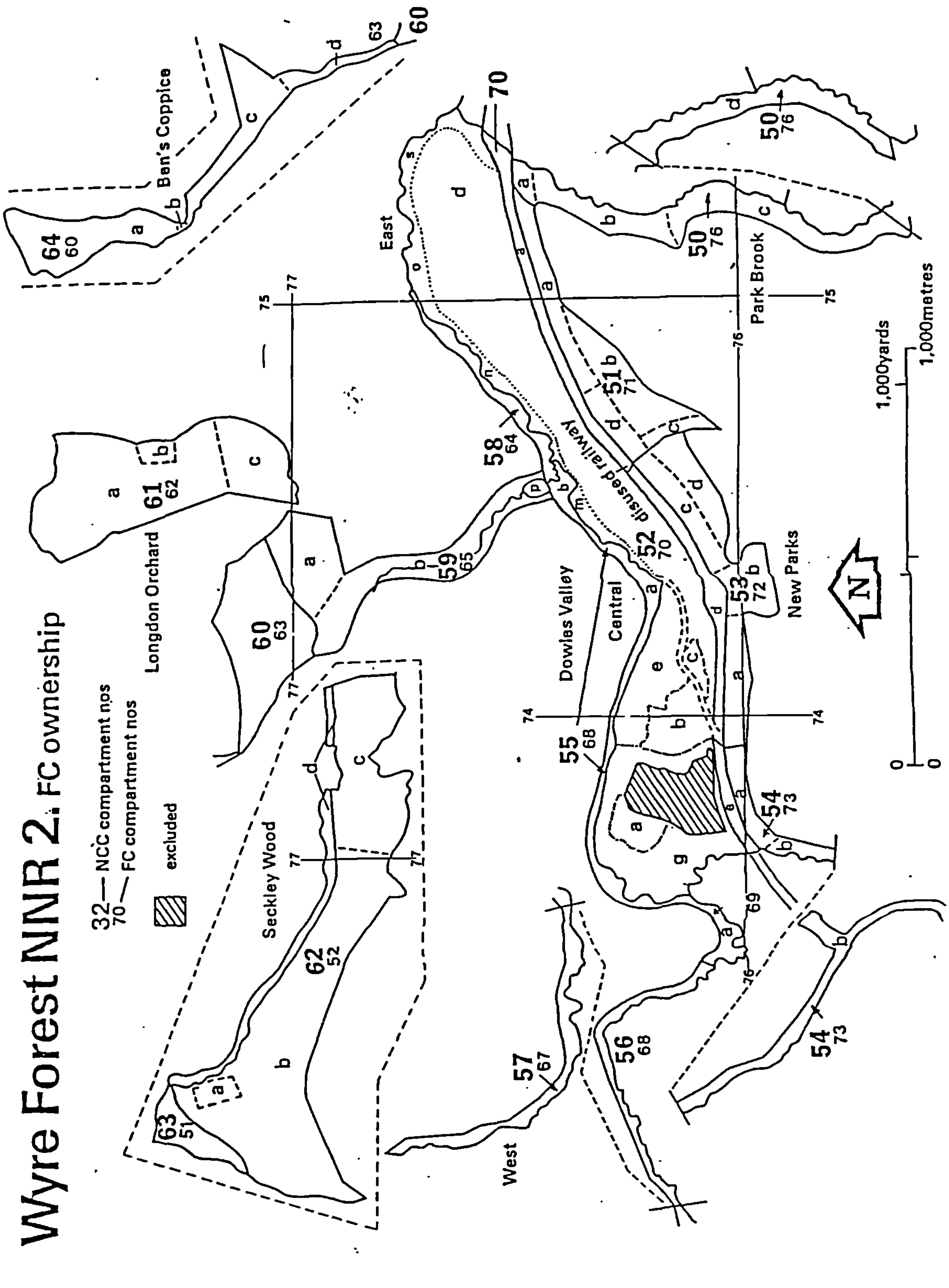
The eight plantations surveyed in the ISA study. Information includes the quadrat sequence numbers; compartment numbers; and vegetation cover

The seven wetland sites surveyed in the ISA study. Information includes the number of species recorded in each case; compartment numbers; and vegetation cover.

	FORESTRY PLANTATIONS SURVEYED FOR THE ISA STUDY							
		PLANTATION CODES						
	8064	8067(a)	8068(a)	8059(a)	8078(b)	8078(j)	8070(b)	8079(e)
Quadrat numbers	121-150	91-120	31-60	61-90	151-175	207-237	176-206	1-30
Number of species	25	11	18	20	18	31	42	22
Canopy cover (%)	85(70-90)	80(75-90)	65(60-75)	90(85-95)	65(60-75)	65(60-75)	85(75-90)	70(65-75)
Shrub cover (%)	2(0-5)	10(5-15)	2(0-5)	0	5(0-8)	15(5-20)	15(5-20)	2(0-4)
Field layer cover (%)	40(10-70)	80(60-100)	70(40-80)	9(0-11)	74(45-100)	78(40-100)	60(38-95)	88(50-95)
		WETLAND FLUSH SITES SURVEYED FOR THE ISA STUDY						
		PLANTATION CODE						
	8080(b)	8062(c)	8065(a)	8067(b)	8073(b)	8077(b)	8061(j)	
Number of species	14	8	19	16	16	23	30	
Field layer cover (%)	61-88	100	74-100	94-100	50-87	100	100	

APPENDIX 8.2.1

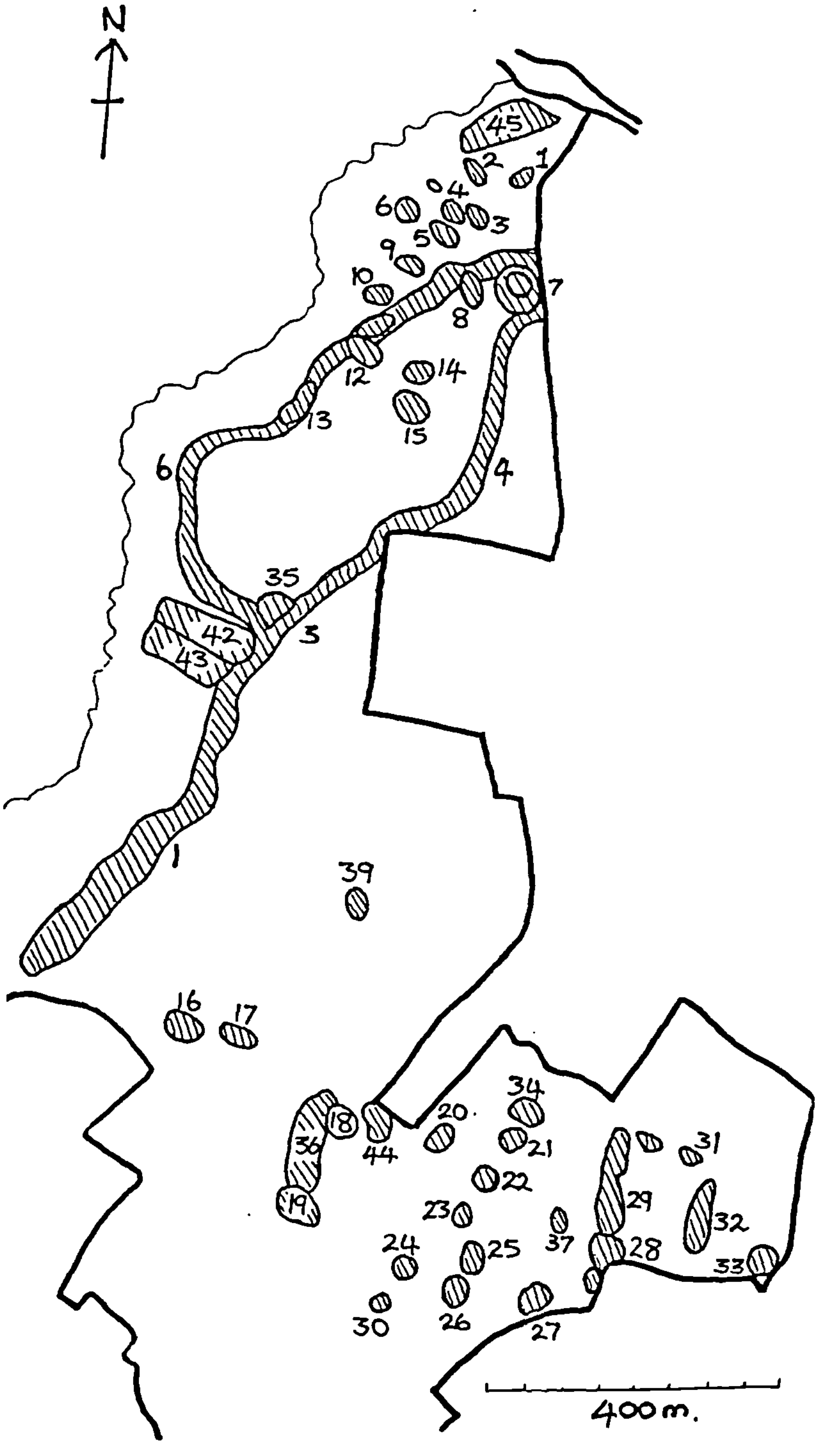
National Nature Reserve sites within the Forest Enterprise section of Wyre Forest



APPENDIX 8.2.2

Map of Shelfheld and Lord's Yard Coppice with the location of coppice coupes and rides. These areas are currently being managed by English Nature, Wyre Forest

No.	DATE CUT.	DATE FENCED.
1	1984/5	Feb/Mar 1989
2	1984/5	
3	1984/5	
4	1984/5	
5	1984/5	
6	1984/5	Feb/Mar 1989
7	(7A 1990/91)	(7A 1990/91)
8	1986/7	
9	1984/5	Feb/Mar 1989
10	1984/5	
11	1984/5	
12	1984/5	1988/9
13	1984/5	—
14	1984/5	
15	1984/5	
16	1980/1	Oct/Nov 1988
17	1981/2	—
18	1982/3	Dec 1988
19	1988/9	Feb/Mar 1989
20		Feb/Mar 1989
21	1983/4	—
22	1983/4	
23	1983/4	
24	1983/4	Feb/Mar 1989
25	1983/4	Oct 1988
26	1983/4	Feb/Mar 1989
27	1983/4	
28	1983/4	Feb/Mar 1989
29	1983/4	—
30	1983/4	—
31	1983/4	—
32	1983/4	Feb/Mar 1989
33	1983/4	—
34	1984/90	Early 90
35	Early 1991	91/92
36	Early 1991	91/92
37	1983/84	Early 1989
38	1991/1992	91/92
39	1991/92	91/92
40	/93	Early 93.
41	1991/2	91/92
42	1991/2	91/92
43	1992/3	1992/3
44	1994/95	—
45	1995	SEPT 1995
46		
47		
48		
49		
50		
RIDE		
1	1988/89	—
2	1989/90	—
3	1990/91	—
4	1991/92	—
5	1993/4	—
6	1992/93	—
7	1994/95.	—



APPENDIX 8.2.3

Distribution pattern of Fallow deer in Shelfheld and Lord's Yard Coppice. (Each symbol represents a register and total registers are taken from 12 visits over a period of four years).
Shaded areas are glades and coppice coupes.